History of Vegetation Restoration

Whitman Mission National Historic Site

1984-2002

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A. Vegetation Restoration Program-An Overview

Whitman Mission National Historic Site (WHMI) was established in 1936 to preserve the site of a mission founded in 1836 by Marcus and Narcissa Whitman among the Cayuse people of the Inland Pacific Northwest. It is located at the southern extreme of the Palouse Prairie region of southeastern Washington in Walla Walla, WA. The elevation within Whitman Mission NHS ranges from 615 feet above sea level to 724 feet at the top of Memorial Hill, which rises over 100 feet above the surrounding countryside.

Whitman Mission National Historic Site is surrounded by a dry, moderate climate. Annual precipitation in the vicinity of the NHS averages 19.48 with approximately 17.8 inches of snow during the winter months. The daily temperature variation can be as much as 40 degrees during the summer. Mean monthly maximum temperature ranges from 40.1 to 97.3 degrees Fahrenheit, while mean minimum temperature ranges from 26.6 to 57.4 degrees Fahrenheit. Frequent, strong winds can occur anytime, as well as Chinook winds. Prevailing winds year around come from the southwest.

Resource management at this site is dedicated to preserving the archeological, historical and landscape values associated with the Whitmans during their work from 1836 to 1847. These include native vegetation and landscape features the Whitmans would have seen and used during their lives at the mission.

A major objective listed in the general management plan for the park is to restore and preserve the park's natural resources, including riparian and wetland areas, and the cultural landscape. Strategies listed to achieve this objective include: 1) identify options for Doan Creek and irrigation ditch management and implement the selected option, 2) manage vegetation, and 3) collaborate with other federal and state agencies in the protection of hydrologic and aquatic resources.

The restoration of native and native-appearing vegetation at the Whitman Mission National Historic Site has been an important objective for park management for over fifty years. Restoration work first began in 1950, when Robert Weldon first planted ryegrass.

However, it was not until the mid-1980's that significant, large-scale efforts were actually undertaken. One of the early important studies that laid the groundwork for the restoration program was the *Landscape Study and Management Alternatives for Revegetation* of the Mission by Cathy Gilbert, a Park Service landscape architect, completed in 1984. Other researchers and scientists involved in the restoration program over the years included:

Robert Amdor, Superintendent, Whitman Mission (1982-1987)

Ed Starkey, Research Biologist, NPS (1983-1992)

James Larsen, Chief Scientist, NPS (1983-1988)

Jim Romo, University of Saskatchewan (1983-1986)

Larry Larson, Oregon State University (1985-1992)

Dave Herrera, Superintendent, Whitman Mission (1987-1990)

Roger Trick, Chief Ranger, Whitman Mission (1983-2003)

Staff at Whitman Mission

To grasp a sense of how the landscape looked in the early 1980s as well as what the restoration program has achieved in the last twenty years, it is instructive to read Gilbert's 1984 assessment of the landscape. Her study noted the high degree of modification of the landscape that had taken place both during Whitmans' settlement and afterwards.

A significant statement from her report states:

> "Vegetation on the lands within the Park has been altered to the point that, as far as can be determined, virtually no area of the native vegetation remains. The area south of the Mission site is in pasture; Shaft Hill has been cultivated and overgrazed during the past years, as was the northern section; and the Mission site and Visitor Center grounds have been landscaped. Noxious weeds infest most of the ground cover to a degree that requires control measures be taken to be sensitive to the problems that led to their being targeted under the State and County Noxious Weed Control Program, and to prevent the weeds from being an irritant to the visitor and adjacent landowners".

Beginning in 1984, scientists and researchers visited the Mission numerous times, making observations and offering specific recommendations regarding intensive treatments, selecting species of plants for restoration, and documenting successes as well

as failures. These documents or excerpts from them are referenced in Appendix A. National Park Service employees were responsible for implementing the recommendations made by scientists and researchers.

An overview of the progress of the program is described in the *2000 General Management Plan* for the Mission. An excerpt from that document states:

> "In 1985, the NHS staff began a restoration project with the objective to control non-native weeds that had invaded the park. Some of these plants were on the state and county noxious weed lists as targeted weeds for control and are still serious threats to local agriculture. The short-term goal of the NHS staff was to establish healthy stands of grass to successfully compete with these weeds. The non-native grass species were chosen for the following reasons: the species had a good chance for success against the noxious weeds and the weed seeds still in the soil, and they would be similar in appearance to grasses that may have been growing there 150 years ago. Once these grasses were established, the park staff then would be able to gradually replace the non-native grasses with native species thought to be present during the Whitman's time. This action is in concurrence with the 1984 *Landscape Study and Management Alternatives for Revegetation: Whitman Mission National Historic Site* that states that the overall goal for restoration is to maintain the visual aspect of the historic period (USDI 2000).

In 1989, the NHS staff established a native rye grass demonstration plot by the visitor center. It was planted in a native plant mixture of Magnar Great Basin wildrye (*Leymus cinereus*) and Sherman big bluegrass (*Poa secunda*). The Magnar Great Basin wildrye grows six to eight feet tall and the Sherman big bluegrass grows two to three feet tall. The bluegrass did not compete well and the entire area is gradually becoming Magnar Great Basin wildrye.

In 1987 and 1988, the 28 acre river oxbow and pasture area was planted with both native and non-native species to reproduce the historic scene. The native Magnar Great Basin wildrye was planted along with two species of non-native grasses, reed canary grass (*Phalaris arundinacea*) and Alkar tall wheatgrass (*Elytrigia pontica*). The Alkar tall wheatgrass is the main grass in this area and grows to four feet tall. The reed canary grass grows well on poorly drained soils.

Another native plant that has been discussed for possible use on the Mission Grounds is Sodar streambank wheatgrass (*Elymus lanceolatus*). This plant is a native, sod forming grass that grows six to eighteen inches tall. It grows well on a variety of soils and can handle the dry conditions of summer.

By 1985, major emphasis for maintenance within the NHS was being placed on restoration and the control of exotic plant species. Vegetation management has converted 65% of the NHS from exotic grasses and weeds to grasses that grew in the area during the Whitman's era, or to grasses that have the same appearance as the native grasses. These native-appearing grasses will gradually be replaced with native species by NHS staff.

A vegetation plan was developed by the NHS staff and implemented for the area surrounding the visitor center. In 1995, vegetative alternatives were developed for treating exotics on the banks of the irrigation channel. Some implementation has been initiated.

In 1997, an inventory of exotic pest plant species identified the following six species of concern: field bindweed (*Convolvulus arvensis*), jointed goatgrass (*Aegilops cylindrical*), poison hemlock (*Conium maculatum*), yellow starthistle (*Centaurea solstitalis*), Canada thistle (*Cirsium arvense*), and Scotch thistle (*Onopordum acanthium*). Control strategies for these species have been developed, and incorporate more extensive use of integrated pest plant management techniques.
(Source: USDI, National Park Service, Whitman Mission National Historic Site. General Management Plan, September 2000)

B. Landscape Study as the Basis for Restoration Program

Gilbert (1984) wrote a landscape study plan that formed the basis for the restoration program that has continued at WHMI since 1984. The study area was divided into six landscape units. Although the units were subsequently subdivided into several sub-units, these initial land unit designations formed the basis for subsequent studies. Descriptions of the original land units and alternatives for restoration are noted below. A map of the vegetation restoration land units is located in Appendix C.

Area A

This area is outside the Park Boundary and is not managed by the Park. Area A is of concern to the Park because of the effect of adjacent land uses on park resources.

Area B

Area B includes approximately 28 acres of pasture at the southern end of the park, south of the Mission Grounds and Millpond. It extends to the south boundary fence.

Alternatives for this land unit are [1] Restore Original Vegetation; Bluebunch wheatgrass (*Agropyron spiceyum*), Sandberg blue (*Poa secunda*), and riparian woodland with grant rye, [2] Seed to Tall wheatgrass (*Agropyron elongatum*), fence into three pastures, and rotate grazing, [3] Seed to tall wheatgrass and use as a single pasture, [4] Utilize existing pasture, construct fences (multi-pastures), and develop rotational grazing, and [5] Continue current management program, but adjust stocking rates and season of use to reduce impact.

Area C

This area includes approximately 8 acres and the hill known as Shaft Hill. This is part of the geological terrace rising approximately 100 feet above the mission. Alternatives for this land unit are [1] Re-establish original native vegetation; Bluebunch wheatgrass and Idaho fescue with a mixture of scattered rabbitbrush and big sage, [2] Reinforce establishment of native species; bluebunch wheatgrass, [3] Maintain present "shady lane" character of trail between units C and F with stature trees by transplant of similar species as current trees become hazardous, and [4] replace irrigation ditch species with shrub-like native/non-native species that act as bank stabilizers.

Area D

Area D includes approximately 40 acres in the northern most portion of the Park. Alternatives for this land unit are [1] Re-establish native vegetation; the text says that this is not feasible because of previous man-caused disturbances, and is an admixture of noxious weeds and non-desirable grasses with high gopher population, [2] Retain present situation, while controlling weeds with chemical treatments, [3] Establish a stable non-native grassland community, using mechanical and chemical treatments, summer fallowing and seeding with native/non-native desirable species.

Area E

Area E includes seven acres of land in the center portion of the park which includes the visitor center, roads, and parking areas. Alternatives for this land unit are [1] Restore native vegetation. This area has been heavily modified to the extent that all but vestiges of native vegetation have been removed. Restoration is not achievable, nor is it necessarily desirable. [2] Maintain current vegetation cover, but control noxious weeds and undesirable plant and animal species.

Area F

Area F includes approximately seven acres and constitutes the historic core of the site. Alternatives for this land unit are [1] Restore native vegetation. Because of the large numbers of visitors, complete restoration is largely impossible, and may be undesirable, [2] Maintain the core area as is currently being done.
(Source: Gilbert, C.A., USDI National Park Service, 1984. Landscape Study and Management Alternatives for Revegetation, Whitman Mission National Historical Site. National Park Service Interdisciplinary Study by the Pacific Northwest Regional Division of Cultural Resources, Science and Technology, Resource Management.)

C. Historic Setting - Native Vegetation

To gain a sense of what the restoration program was attempting to accomplish, it is necessary to understand what the native vegetation at the Mission was when the Whitmans first settled the area.

The Whitman Mission National Historic Site is located on the southern extreme of the Palouse Prairie Region in eastern Washington state. Originally, this prairie was dominated by perennial grasses, principally bluebunch wheatgrass (*Elymus lanceolatus wawawai*), which flourished over the plains. Intermixed with it were smaller patches of sandberg bluegrass (*Poa secunda*) and Idaho fescue (*Festuca idahoensis*). This region is classified as the Agropyron-Poa habitat type (formerly named *Agropyron spicatum*, new listing is *Pseudoreognaria spicata*). Large native herbivores were generally absent from the Palouse, and because of this, the grasses evolved with a low resistance to grazing. Subsequent grazing by domestic livestock and extensive cultivation for wheat are the main reasons why native perennial grasslands are now rare on the Palouse.

The Cayuse Indians inhabited the area around Whitman Mission NHS prior to the 1850s. They practiced very little crop agriculture, depending instead on a partially nomadic existence, which emphasized food gathering, horse rearing, and salmon fisheries. Fire was used periodically by the Cayuse to burn particular areas to increase the production of wild forage and accessibility of plant foods, to facilitate hunting and travel by burning away underbrush, and to encircle game. The regularity with which the areas on, or near, the historic site were burned historically cannot be determined, but frequent cultural burning of any particular area was probably rare.

It is probable that at the time the mission was established, a mixture of three plant communities occupied the site. At the time the mission was established in 1836, the Walla Walla River flowed through the site during times of high water. On the floodplains along the Walla Walla River and nearby Mill Creek, a narrow plant community consisting of dense tangled thickets of willows (*Salix spp*.), cottonwoods (*Populus trichocarpa*), wild dogwoods (*Cornus spp*.), blackberries (*Rubus spp*.), elderberries (*Sambucus spp*.), and other species common to riparian areas probably occurred. An association of perennial grasses, shrubs, and native forbs occupied the hillside area where soil depths and drainage were greater. Perennial grasses common to the Palouse dominated the rest of the Whitman Mission.

Intermixed throughout the site was giant wild ryegrass (*Leymus cinereus*, formerly *Elymus cinereus*), a species preferring a year-round supply of soil moisture and occurring primarily on clay bottomlands and seepage areas. It now occurs as scattered

large bunches of grass, but historically, it may have been more extensive. It was this species that gave the Indian name to the location, *Waiilatpu*, meaning, place of the people of the rye grass.

It is likely that the Cayuse used the resources at the site at least periodically for centuries before the mission was established. Archeological evidence of modification to the natural conditions has not been documented. However, soon after the mission was established, an irrigation system was developed, crops were planted, and areas were opened to grazing by draft stock and cattle. A considerable number of stock animals moved through the mission from the Oregon Trail, and there was ample opportunity for the introduction of exotic plants. The changes that occurred to the plants and the landscape during the time the mission was active-the introduction of domestic livestock, exotic plants and agriculture, and the removal of riparian vegetation for fuel and lumber-were a portent of things to come for the entire Palouse Prairie.
(Sources: USDI, National Park Service, Whitman Mission National Historic Site. General Management Plan, September 2000, and Wright, R.G. A Profile of the Original Plant Communities At Whitman Mission NHS: A Draft Report, 1984).

D. History of Exotic Weed Invasions

Integral to a restoration program is the understanding that a major component of such a project must deal with non-native (exotic) plants which have invaded and taken over many of the landscapes from the native vegetation.

Along with the settlement of the west came agriculture and the introduction of exotic weed species. Most exotic weeds found within Historic Sites and National Monuments were introduced into this region in the late 1800s and early 1900s. These species include the knapweed complex (*Centaurea, spp.* L), cheatgrass (*Bromus tectorum* L.), medusahead wildrye (*Taeniatherum caput-medusae* L.), and numerous other species. Most weed introductions began as contaminates in crop seed, livestock feed, or shipping ballast that was being transported along the waterway and railway routes of the region. These initial introductions expanded as land use patterns developed within the region. Today most rangelands, forestlands, and croplands support exotic weed species in varying amounts.

The encroachment of exotic weeds onto Park lands is associated with past and present land-use. Whitman Mission and the surrounding area reflect a rich history of settlement, domestic livestock grazing, farming, and commodity transportation. The landscape reflects the cumulative influence of over 100 years of white settlement. Furthermore, many of the cultural activities that impacted this landscape were continued after these areas were incorporated into the National Park system and some of these activities are continued today to maintain historic settings.

This historical perspective illustrates that the history of Park lands and exotic weeds are not independent . Indeed, the very land uses that justified the creation of this historic site are often the same attributes that aided the spread of exotic weed species. Furthermore, the process of weed encroachment will continue in the future because most historic sites and national monuments are surrounded by land use patterns that maintain exotic weed populations.

(Source: Larson, L., and McMinnis, M. Exotic Weed Management on National Historic Sites and Monuments in the Pacific Northwest. Department of Rangeland Resources, Oregon State University, No date. Excerpts relating to WHMI.)

E. Ecological importance of Exotic Plant Invasions – Effects on Native Vegetation

Weed encroachment is a complex problem and successful solutions need to be based upon ecological principles. Land managers need to incorporate life strategy information, and an understanding of the role of disturbance within plant communities into exotic weed management programs.

Plant communities are dynamic systems in which vegetation change and disturbance are constantly occurring. Successful plant introductions, whether exotic or native, occur because sufficient quantities of light, water, nutrients, temperature, and space are available within a plant community for new introductions to complete their life cycles. In other words, the composition of a plant community is the product of the allocation of limited resources (light, water, nutrients, temperature, and space) among potential plant species. Each new generation of an introduced species adjusts the process of resource allocation until a balance is achieved among the competing life strategies.

The encroachment of exotic weed species onto Park lands is an example of an evolving ecological balance among competing life strategies. Unfortunately, weed encroachment is occurring on both deteriorated as well as undisturbed Park lands. Weed encroachment is most obvious on deteriorated Park lands where it can disrupt successional processes and displace native plant species. In contrast, weed encroachment into undisturbed plant communities tends to be more subtle. In this situation weeds enter the community as scattered individuals, followed by the domination of localized areas of community disturbance. These two scenarios illustrate the breadth of the problem faced by Park managers and the difficulty associated with the development of management strategies against the encroachment of weeds.

AN EXAMPLE OF THE PROBLEM

The ecological complexity of weed encroachment can best be illustrated by describing life strategy attributes that result in encroachment success. The species selected for this illustration is yellow starthistle (*Centaurea solstitialis* L.)
Yellow starthistle is an annual member of the knapweed complex and is solely dependent upon seed reproduction for its maintenance within plant communities. It is a Eurasian native that was introduced into the western United States at the turn of the century and currently infests millions of acres of range and cropland. Much of the success of yellow starthistle can be attributed to the high level of seed production and an ability to preempt resource utilization by other species.

The seed dispersal pattern of starthistle maximizes the likelihood of mature seed landing in an environment favorable to germination. This is accomplished through the production of two seed types and the utilization of two time periods in which seeds are released. Plumed seeds are produced in the outer portion of the seed head and are dispersed through wind action during the summer and fall away from the parent plant. Plumeless seeds are produced in the center of the seed head, are not released until winter, and then drop in the immediate vicinity of the parent plant.
(Source: Larson, L. and McMinnis, M. Exotic Weed Management on National Historic Sites and Monuments in the Pacific Northwest. Department of Rangeland Resources, Oregon State University, No date. Excerpts relating to WHMI.)

II. Year –to-Year Treatments – Documented by Land Unit

This section of the Restoration Report spells out documented actions that have taken place at the Whitman Mission National Historic Site within the past twenty years. This discussion is divided by the areas as initially designated by Cathy Gilbert, and later subdivided by various researchers.

Area A - *This area is outside the Park.*

Overview and Recent Activities:

Area A is the general designation for all land outside of the Whitman Mission NHS boundary. Each side of the park has slightly different land uses and needs slightly different efforts within the park next to the boundary fence. Very little cooperation has occurred between park management and the adjacent landowners since the restoration project began in the early 1980s. Park natural resources management should work with the Walla Walla County weed control officer in cooperative efforts around the park. No park operating funds can be used outside of the park, but the timing of herbicide applications or prescribed burns, and coordination of basic weed control strategy is important.

Outside the north boundary fence is Union Pacific Railroad land. Park staff mow the fence line inside the park, which is part of Area D1. Problem species such as poison hemlock, cheatgrass, and teasel grow on both the park side and the railroad side of the fence. Park staff does not mow along the boundary fence in the extreme northwest corner of the park, northwest of Mill Creek. Poison hemlock is the dominant species in D4 up to the boundary fence. Outside the fence, on railroad land, the park neighbor mows between his property line fence and the tracks in an effort to keep weeds such as thistles, quack grass, and field bindweed controlled. He mows the railroad land adjacent to D4b at the same time.

Land adjacent to the west boundary is used for pasture or for commercial wheat production, and is on a lifetime lease to the former owner. When the current leasee (former owner) and his spouse are deceased, which may be 20 years from now, the land

will belong to Whitman Mission National Historic Site. The park staff does not mow along the fence line in Areas D or F, but does mow along the fence in Area B along the west boundary. Poison hemlock, cheatgrass, and Canada thistle are the predominant weeds along the park's west side, and they put some pressure on the adjacent private land for weed control. The pasture areas adjacent to Area B, D4, and part of D3 are so closely cropped that there is little chance for thistle or poison hemlock to grow. The park neighbor replants the wheat field adjacent to Area D3 every year.

The Washington State Fish and Game Department administers the land along the Walla Walla River adjacent to the park's south boundary as a wildlife habitat. Since 1989, the park staff mows an 8-foot strip along the entire south boundary fence within the park. Weed control is difficult, especially for poison hemlock, which grows on both sides of the south boundary fence. A variety of weed seeds probably enters and leaves the park through the south boundary.

The east boundary of the park is more complex because it includes the Memorial Shaft Hill as well as agricultural land. All the adjacent land is privately owned and produces wheat or onions except where the hill slope is too steep or where the land is too wet near Doan Creek. Non-native plants that spread from the park include Canada thistle, yellow starthistle, cereal rye grass, and cheatgrass. Weeds enter the park along the steep slopes of the Memorial Shaft Hill. The most common ones are cheatgrass and yellow starthistle. Aquatic weeds come into the park along Doan Creek.

The park staff began mowing along the fence line in Area B, and in Area D1. Every late spring a park maintenance crew pulls cereal rye grass from all areas within 30 feet of the fence line on top of the hill. This protects the adjacent landowner's wheat from harboring the cereal rye grass.

Since 1982, the park has experience three wildfires on the hill. One of these spread across the park boundary and burned the steep, uncultivated slope on the south aspect of the hill to the east of the park. Park neighbors have failed to control their burning on two occasions in the last 20 years, with fire crossing the boundary into the park. Again, this was on the steep hillside, one on the south aspect and one on the north side of the hill.

Both Whitman Mission National Historic Site and the park's neighbors on the east and west would benefit from coordinated and cooperative efforts to control those species on the county noxious weed list. While either park staff or an adjacent landowner mention this idea occasionally, no one has implemented it as of 2002. Mutual coordination and cooperation with the county weed control officer as the consultant should be encouraged on weed control both inside and outside of the park boundary. (Source: Trick, Roger, WHMI. 2002. Revegetation updates)

Area B - *This area includes 27 acres south of the Mission Grounds, and includes the River Oxbow, and Pasture Area.*

Overview and Recent Activities:

Area B was grazed, and then replanted with native and introduced grasses in 1987 and 1988. By 1990, the grasses were still vigorously growing. Park staff made only spot spray applications of broadleaf herbicides during that time. Canada thistle and poison hemlock began to invade the area in the early 1990s. Since that time one patch on the east side of Area B, and a patch in the southeast corner, and a patch in the southwest corner have seen more Canada thistle or poison hemlock, or both invade the grass. These areas are "spot mowed" almost every summer, as well as "spot sprayed" with herbicides.

Park staff and the local USFS district fire personnel burned Area B in March 1994 to remove the dead biomass and re-invigorate the grass stand. Approximately two to three weeks later, the park staff sprayed the area with a broadleaf herbicide. This controlled most weeds for that summer and the next. In March 1996, the area was burned again and sprayed with a broadleaf herbicide to control weeds.

In order to control the poison hemlock and Canada thistle in the southeast corner of Area B, about a two-acre patch, the park purchased a six-foot wide John Deere rototiller and tilled the problem area. Park staff seeded the patch with great basin wild ryegrass and tall wheatgrass in the spring, 1996. The grass germinated and grew until warm and dry weather halted growth in June. A large population of poison hemlock overtopped the grasses and continued to dominate this corner of Area B.

Throughout the late 1990s, park staff continued to "spot mow" patches of Canada thistle and poison hemlock. The strategy was to mow the weeds to keep them low

enough that a boom sprayer could be pulled through the weed patch to provide an even and thorough herbicide application. This strategy would work only in the early spring. Once weeds became too tall in late spring, they could be mowed again, but only to cut off immature seed heads. Some springs, when there were other higher priority duties, the weeds grew too tall to use the ditch bank mower or the flail mower with the Ford tractor. The only strategy then was to wait until the next spring to combat the weed patch.

In the southwest corner of Area B, a patch approximately one acre, cheatgrass had become the dominant plant. In the late 1990s, park staff broadcast sprayed this area with a general herbicide to kill the cheatgrass. Immediately after that, the weather turned to the summer warm and dry pattern. As a result, the area was not seeded and a new crop of cheatgrass grew.

Since 2000, patches of Area B have been "spot mowed" to allow spring spraying, and spot mowed again later in the summer to cut off seed heads. In 2002, almost the entire 28 acres were mowed. In addition, in 2002, the park staff distributed 250 defoliating hemlock moth caterpillars (*Agonopterix alstroemeriana*) in a one-acre patch of poison hemlock in the center of Area B. Large areas of non-native plants continue to grow in Area B, with spikeweed (tarweed), poison hemlock, and Canada thistle being the most common ones. (Source: Trick, Roger, WHMI. 2002. Revegetation Updates)

Other Earlier Documented Actions:

1. Area B was grazed early spring 1986 and Roundup was applied to kill perennial grasses in preparation for seeding. (Source: Jim Romo, Letter to Robert Amdor dated July 7, 1986)
2. 1987 Report describes a tour of Whitman Mission by Larry Larson, Bill Krueger (Head of Rangeland Resource Department at OSU), Ed Starkey NPS, and Whitman Mission Staff conducted April 8, 1987. During the tour it was noted that between 90-100% of the target species (Kentucky bluegrass, quackgrass, and clover) had been eliminated from Area B with the application of Roundup made in the spring of 1986. (Source: Larry Larson. Report to Roger Trick WHMI dated April 9, 1987, received April 13, 1987)

3. An Individual Fire Report dated May 29, 1987 documents a prescribed burn of 29 acres in Area B. (Source: WHMI. Individual Fire Report, May 29, 1987)
4. 1987 Report states that Area B was treated with Roundup according to previous recommendation made in April 9, 1987 report. The area was burned at a later date to remove the dead material from the site. The treatment of the site was effective over 85-90% of the area. (Source: Larry Larson. Report dated June 22, 1987)
5. 1988 Report states that on a February 25, 1988 trip to WHMI the following were observed: [1] grass seedlings approximately 1-2 inches in height were observed on all areas that had been seeded in the fall (1987).[2] the portion of Area B that was roto-tilled last fall had numerous weed seedlings and was too wet to be seeded. On the March 11, 1988 trip the following were observed: [1] the tilled portion of Area B was seeded with a mixture of tall wheatgrass, basin wildrye, and pubescent wheatgrass. The swale areas were too wet to be drilled so they were broadcast seeded with reed canarygrass, sheep fescue, Sherman big bluegrass, tall wheatgrass, and basin wildrye. On an April 13, 1988 trip the grass seedlings were vigorous and were at the 4-5 leaf stage. (Source: Larry Larson. Letter to Ed Starkey dated April 18, 1988)
6. 1988 Annual Report covers the period from April 1987 through December 1988. Observations include the following: In April 1987 Area B was dominated by annual and biennial weeds. The weed population was a direct result of an application of Roundup the previous year (1986) to remove non-pasture grasses, while creating a 28-acre weed patch. Area B was sprayed with Roundup in late April (1987) to begin the process of seedbed preparation for a fall seeding. The area was burned in late May (1987) to remove the residue. Weeds began to re-infest the area in Area B in June. The infested area was spot treated with Roundup in late June with limited success. It was decided to till the area instead of spraying, and in late September, the infested area was tilled, in preparation for spring seedbed planting. In late October of 1987 the untilled portion of Area B was seeded with a John Deere Power Seeder. The seed mix was comprised of 40% Alkar Tall Wheatgrass, 40% Magnar Basin Wildrye,

10% Luna Pubescent Wheatgrass, and 10% Secar Bluebunch Wheatgrass. In mid-March (1988), the tilled portion of Area B was dried sufficiently to permit the area to be seeded. The John Deere Power Seeder and the same seed mix were used on this portion of the area. The old river channel was broadcast seeded at the same time with a mixture of Sherman Big Bluegrass and Vantage Reed Canarygrass. In mid April, the fall seeding contained patches of henbit (*Lamium amplexicaule*) that were beginning to compete with an otherwise vigorous stand of grass. In early May the fall seeding was mowed to a 6-inch height in an attempt to stunt the henbit and release the grass. In mid-May it became clear that both the fall and spring seedings would require herbicide treatment if the grass stands were going to survive. The fall seeding was treated with Banvel and 2,4-D mix. The spring seeding was treated with Glean in May and the Banvel and 2,4-D mix in June. Later in June-August observations, the weeds had clearly been suppressed, although not eliminated, and the grass stands appeared to be successful. (Source: Larry Larson. Annual Report. 1988. Covers period from April 1987 through December 1988, and is included in a photo album of the various treatments)

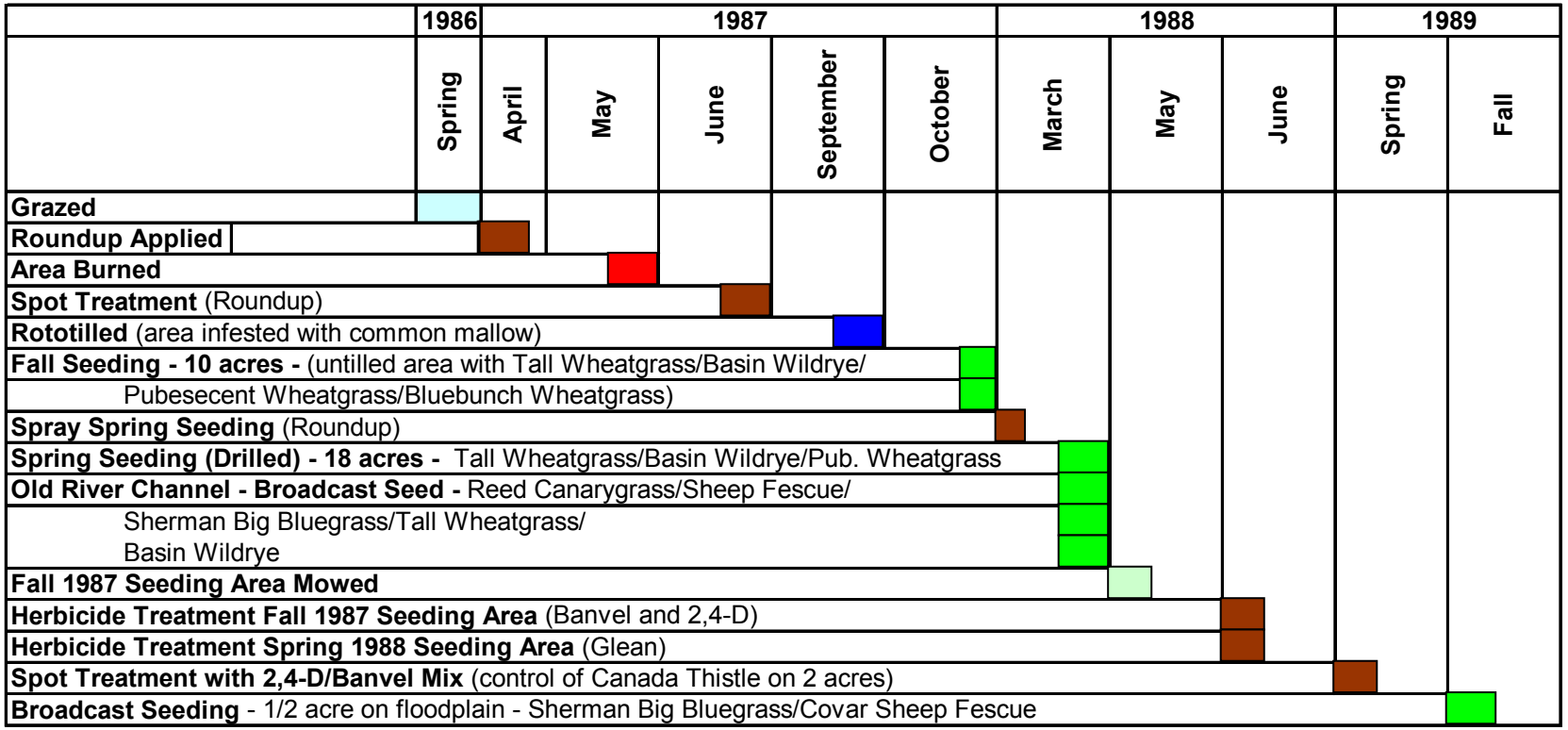
7. The 28-acre river oxbow and pasture area was planted with both native and non-native species in 1987 and 1988, including native Magnar Great Basin wildrye, along with two species of non-native grasses, reed canarygrass and Alkar tall wheatgrass. (Source: USDI National Park Service. General Management Plan, September 2000)
8. The only activity scheduled to Area B in the fall of 1989 was a broadcast seeding of Sherman big bluegrass and Covar sheep fescue. This seeding occurred on a ½ acre area of the flood plain where the soil is too shallow (gravel bar) to support a dense stand of tall wheatgrass. Actions completed Personal Communication, Roger Trick, 2001. (Source: Larry Larson. Whitman Mission Annual Report, 1989. Received WHMI Dec. 20, 1989.)
9. 1994-Park staff and the local USFS district fire personnel burned Area B in March 1994 to remove the dead biomass and re-invigorate the grass stand. Approximately two to three weeks later, the park staff sprayed the area with a

broadleaf herbicide. This controlled most weeds for that summer and the next. (Source: Trick, Roger. WHMI. 2002. Revegetation Updates)

10. 1994-An Individual Fire Report dated March 15, 1994 documents a prescribed burn of 29 acres in Area. B. (Source: Individual Fire Report, March 15, 1994)
11. 1996- In March 1996, the area was burned again and sprayed with a broadleaf herbicide to control weeds. In order to control the poison hemlock and Canada thistle in the southeast corner of Area B, about a two-acre patch, the park purchased a six-foot wide John Deere roto-tiller and tilled the problem area. Park staff seeded the patch with great basin wild ryegrass and tall wheatgrass in the spring, 1996. The grass germinated and grew until warm and dry weather halted growth in June. A large population of poison hemlock overtopped the grasses and continued to dominate this corner of Area B. (Source: Trick, Roger. WHMI.2002. Revegetation Updates)
12. 1996-An Individual Fire Report dated March 19, 1996 documents a prescribed burn of 25 acres on March 19, 1996. (Source: Individual Fire Report, March 19, 1996)
13. 1998-An Individual Fire Report dated March 5, 1998 documents a prescribed burn of 28 acres on March 5, 1998. (Source: Individual Fire Report, March 5, 1998)
14. Late 1990-2002-Throughout the late 1990s, park staff continued to "spot mow" patches of Canada thistle and poison hemlock. The strategy was to mow the weeds to keep them low enough that a boom sprayer could be pulled through the weed patch to provide an even and thorough herbicide application. This strategy would work only in the early spring. Once weeds became too tall in late spring, they could be mowed again, but only to cut off immature seed heads. Some springs, when there were other higher priority duties, the weeds grew too tall to use the ditch bank mower or the flail mower with the Ford tractor. The only strategy then was to wait until the next spring to combat the weed patch. In the southwest corner of Area B, a patch approximately one acre, cheatgrass had become the dominant plant. In the late 1990s, park staff broadcast sprayed this area with a general herbicide to kill the cheatgrass.

Immediately after that, the weather turned to the summer warm and dry pattern. As a result, the area was not seeded and a new crop of cheatgrass grew. Since 2000, patches of Area B have been "spot mowed" to allow spring spraying, and spot mowed again later in the summer to cut off seed heads. In 2002, almost the entire 28 acres were mowed. In addition, in 2002, the park staff distributed 250 defoliating hemlock moth caterpillars (*Agonopterix alstroemeriana*) in a one-acre patch of poison hemlock in the center of Area B. Large areas of non-native plants continue to grow in Area B, with spikeweed (tarweed), poison hemlock, and Canada thistle being the most common ones. (Source: Trick, Roger. WHMI. 2002. Revegetation Updates)

Area B – Whitman Mission National Historic Site 1986-1989



Legend
Area Treatments
Grazed
Round-up
Burned
Rototilled
Seeded
Herbicide
Mowed
Biocontrol

Area B – Whitman Mission National Historic Site 1991-2002

		1991	1992	1993	1994	1994	1995	1996	1996	1997	1998	1999	2000	2001	2002
		Summer	Summer	Summer	Spring	Summer	Summer	Spring	Summer	Summer	Summer	Summer	Summer	Summer	Summer
Spot spraying - Canada Thistle															
Spot mowing - Poison Hemlock															
Area Burned - NPS/USFS personnel - March 1994															
Area Sprayed - broadleaf herbicide															
Area Burned - March 1996															
Area Sprayed - broadleaf herbicide															
SE corner patch roto-tilled															
SE corner patch seeded with Great Basin Wild Ryegrass and Tall Wheatgrass															
SW area Broadcast spray area - general herbicide for cheatgrass															
Patches of Area spot mowed															
Patches of Area spot sprayed															
Biocontrol - released 250 defoliating hemlock moth caterpillars															

Legend	
Area Treatments	
Grazed	
Round-up	
Burned	
Rototilled	
Seeded	
Herbicide	
Mowed	
Biocontrol	

Area C - *This area includes approximately 8 acres and the hill known as Shaft Hill. Initially, this was designated as Area C, but later Area H and subdivisions were integrated into this area. Where recommendations and actions were carried out in the area described as "The Hill", these will be listed under both Areas C and H.*

Overview and Recent Activities:

The Memorial Shaft Hill poses special difficulties to restoration because of its steep slopes and generally dry environment. In the early 1990s, yellow starthistle became the dominant plant on the south and west aspects and the flat top of the hill. Cheatgrass was the predominant grass. After the wildfire in 1988, the south aspect of the hill was hydroseeded in the fall of 1989 with Sherman big bluegrass. The fire had not burned enough cheatgrass stems to produce bare ground. The result was that the hydroseeded material did not have good enough contact with the soil, so that while germination was good, actually getting the grass plant to grow was a failure. Cheatgrass and yellow starthistle continued to dominate the slope, and the park staff considered the effort a failure.

Ever since the early 1990s, the park staff used broadleaf herbicides along the eastern part of Area C. This provided a 20 to 30 foot buffer between the park land, which was heavily infested with yellow starthistle, and the neighbors' land. In addition, the park staff would hand pull or string trim cereal rye grass (*Secale cereale*) within the same buffer area before the seed heads were mature. This satisfied the neighboring farmers' concerns about these weeds entering their commercial wheat fields.

A graduate student from Oregon State University, Roger Sheley, used about one acre on top of the hill for research plots in 1992. As part of his dissertation research, he studied the growth of yellow starthistle and cheatgrass under different environmental conditions and at different plant densities. The park staff was able to take some of his research findings and use them to help control yellow starthistle.

After broadcast spraying the top of the hill (H6 also C1) with a general herbicide, the park planted it with bluebunch wheatgrass and other native grasses in 1991. The grasses established themselves over a few years and by the mid-1990s, the top of Memorial Shaft Hill had a good stand of grass that required only spot spraying to control the yellow starthistle.

In 1998, a wildfire burned the lower, flat part of C3 (H4) and part of the north aspect of the hill (H3). Park staff planted this two-acre patch with bluebunch wheatgrass, but most of the replanting failed. It was out-competed by cheatgrass. Yellow starthistle became the dominant weed and has been mowed every summer to cut off seedheads before they mature. Park staff planted the west end of C3 (H4) with great basin wildrye grass and has become an established stand behind the Great Grave and Pioneer Cemetery.

On the recommendation of the county weed control officer, the park applied a different herbicide in 1998 to control yellow starthistle. The herbicide Transline is expensive, but it is effective. It was used first on Area C2 (H5). On the south aspect of the hill in September, 1998 a prescribed fire got out of control and burned almost all of C2 (H5) and a small area of C1 (H6). The prescribed burn was to prepare the area for vegetation plugs to be planted later that fall. Park staff and volunteers planted the grass plugs in October 1998 along the top of the slope and at the bottom near the boundary fence. In early spring, 1999 the same area of the hill was hydroseeded with bluebunch wheatgrass and sheep fescue. The spring and summer of 1999 were warm and dry, and most of the plugs did not survive the summer. Only a small percentage of the hydroseeded area grew grass that survived into the fall. The south aspect of the hill, C2 (H5) contains scattered snow buckwheat, lupine, and a few native grasses. Cheatgrass is the predominant plant.

In 1998 the park bought two biological control agents aimed at yellow starthistle, the yellow starthistle peacock fly (*Chaetorellia australis*) and the yellow starthistle bud weevil (*Bangasternus orientalis*). Park staff distributed the bugs on the west aspect of Memorial Shaft Hill, C3 (H2), in the early summer. Since the spring of 2000, Transline and the biocontrol agents have controlled the yellow starthistle on the west aspect of the hill.

Since 2000, park staff has spot sprayed yellow starthistle on all areas of Memorial Shaft Hill, and kept it under control. Since then, more lupine has been spreading in C2 (H5) and C1 (H6). Park staff may experiment with a new control agent for yellow starthistle. Some research indicates that vinegar, when sprayed on immature plants, will kill up to 90 percent of the yellow starthistle stand. Whitman Mission staff may use this as a spot spray technique and monitor its effectiveness. (Source: Trick, Roger, WHMI. 2002. Revegetation Updates)

Other Earlier Documented Actions:

1. 1988 Approximately 5 acres of the southern aspect and the top of the hill burned in the fall of 1988 when a neighboring farmer lost control of his weed burning fire. The area was then planted a variety of grass seed on top, halfway down the slope and at the bottom of the hill immediately after the fire. The only species to grow in 1989 was Sherman Big Bluegrass. (Source: Larry Larson. Annual Report. 1988. Covers period from April 1987 through December 1988, and is included in a photo album of the various treatments)

2. 1989-90 A four-acre area of the hill (specific area not identified) will be revegetated in late February or early March, 1990. The area includes the land that was accidentally burned last year (south aspect) and a section of land on top of the hill. The top of the hill will be burned in an irregular pattern this fall. In February the burned area and the south aspect will be sprayed with Roundup at the rate of 1 pt/A to clear the area of annual grass competition. Both areas will be broadcast seeded (30 lbs/A) and mulched with clean straw (minimal weed and wheat seed) at the rate of 500 lbs/A. The seed mix will consist of Sherman big bluegrass, Critana thickspike wheatgrass, Secar bluebunch wheatgrass, Sodar streambank wheatgrass, and sand dropseed. A spring application of Glean will probably be required to control yellow starthistle seedlings in the seeding. These recommendations were carried out: Personal Communication, Roger Trick, 2002. (Source: Larry Larson. Whitman Mission Restoration Annual Report, 1989. Received WHMI Dec. 20, 1989.)

3. An Individual Fire Report dated July 1, 1997 documents a prescribed burn of 1.3 acres in Area C. (Source: Individual Fire Report, dated July 1, 1997)

Area C – Whitman Mission National Historic Site 1988-2002

	1988				1989	1990	1990 (spring/summer) - 2002
	September	October	November	December	Fall	Feb./March	
Burned - 5 acres accidental from adjacent land							
Planted - variety of seed-only Sherman Big Bluegrass survived							
Irregular burn							
Burned area sprayed with Round-up							
Areas seeded - Sherman Big Bluegrass, Critarra Thickspike, Wheatgrass, Secar bluebunch, wheatgrass, Sodar streambank wheatgrass,							
Broad leaf herbicide - staff has used herbicide along eastern edge of Area C to control starthistle							
Hand-pull, spot trim - Cereal ryegrass							

Legend	
Area Treatments	
Grazed	
Round-up	
Burned	
Rototilled	
Seeded	
Herbicide	
Mowed	
Biocontrol	

Area C1 - *This area is on the east side of Memorial Hill and Great Grave. The following are documented actions:*

1. 1986 Romo suggests rye is locally abundant along the east side of the unit, and neighboring farmers have expressed concern that the NPS take steps to control this species from escaping into their grain fields. Notes on this report indicate this was done in the summer of 1986. (Source: Jim Romo. Letter and Report to Robert Amdor dated July 7, 1986)
2. 1990s-After broadcast spraying the top of the hill (H6, also C1) with a general herbicide, the park planted it with bluebunch wheatgrass and other native grasses in 1991. The grasses established themselves over a few years and by the mid-1990s, the top of Memorial Shaft Hill had a good stand of grass that required only spot spraying to control the yellow starthistle. (Source: Trick, Roger. WHMI. 2002. Revegetation Updates)
3. 1998-On the recommendation of the county weed control officer, the park applied a different herbicide in 1998 to control yellow starthistle. The herbicide Transline is expensive, but it is effective. It was used first on Area C2 (H5). On the south aspect of the hill in September, 1998 a prescribed fire got out of control and burned almost all of C2 (H5) and a small area of C1 (H6). The prescribed burn was to prepare the area for vegetation plugs to be planted later that fall. Park staff and volunteers planted the grass plugs in October 1998 along the top of the slope and at the bottom near the boundary fence. In early spring, 1999 the same area of the hill was hydroseeded with bluebunch wheatgrass and sheep fescue. The spring and summer of 1999 were warm and dry, and most of the plugs did not survive the summer. Only a small percentage of the hydroseeded area grew grass that survived into the fall. The south aspect of the hill, C2 (H5) contains scattered snow buckwheat, lupine, and a few native grasses. Cheatgrass is the predominant plant. (Source: Trick, Roger. WHMI. 2002. Revegetation Updates)
4. 1998-An Individual Fire Report dated September 16, 1998 documents a prescribed fire of 3 acres in Area C1. (Source: Indivudal Fire Report dated September 16, 1998.
5. 2000-Since 2000, park staff has spot sprayed yellow starthistle on all areas of Memorial Shaft Hill, and kept it under control. Since then, more lupine has been

spreading in C2 (H5) and C1 (H6). Park staff may experiment with a new control agent for yellow starthistle. Some research indicates that vinegar, when sprayed on immature plants, will kill up to 90% of a yellow starthistle stand. Whitman Mission staff may use this as a spot spray technique and monitor its effectiveness. (Source: Trick, Roger. WHMI. 2002. Revegetation Updates)

Area C1 (also H6) – Whitman Mission National Historic Site 1991-2002

	1991	1998		1999	2000 (spring/summer) - 2002
		September	October	Spring	
Broadcast spray - herbicide					
Planted - Bluebunch wheatgrass/native grasses					
Prescribed fire - out-of-control/burned portion of area					
Planted - grass plugs in burned area					
Hydroseeded - Bluebunch wheatgrass, sheep fescue					
Spot spraying - starthistle					

Legend	
Area Treatments	
Grazed	
Round-up	
Burned	
Rototilled	
Seeded	
Herbicide	
Mowed	
Biocontrol	

Area C2 - *This area is a subdivision of Shaft Hill. The following are documented actions:*

1. 1998 An individual fire report dated September 16, 1998 documents a prescribed burn of 3 acres in Area C2.

(Source: WHMI. Individual Fire Report, September 16, 1998)

2. 1998-On the recommendation of the county weed control officer, the park applied a different herbicide in 1998 to control yellow starthistle. The herbicide Transline is expensive, but it is effective. It was used first on Area C2 (H5). On the south aspect of the hill in September, 1998 a prescribed fire got out of control and burned almost all of C2 (H5) and a small area of C1 (H6). The prescribed burn was to prepare the area for vegetation plugs to be planted later that fall. Park staff and volunteers planted the grass plugs in October 1998 along the top of the slope and at the bottom near the boundary fence. In early spring, 1999 the same area of the hill was hydroseeded with bluebunch wheatgrass and sheep fescue. The spring and summer of 1999 were warm and dry, and most of the plugs did not survive the summer. Only a small percentage of the hydroseeded area grew grass that survived into the fall. The south aspect of the hill, C2 (5) contains scattered snow buckwheat, lupine, and a few native grasses. Cheatgrass is the predominant plant. (Source: Trick, Roger. WHMI. 2002. Revegetation Updates)

Area C2 – Whitman Mission National Historic Site 1998 - 2002

	1998			1999	2000 (spring/summer) - 2002
	Spring	September	October	Spring	
Herbicide - Transline applied to starthistle					
Prescribed fire - out-of-control					
Planted - grass plugs in burned area					
Hydroseeded - Bluebunch wheatgrass, sheep fescue					
Spot spraying - starthistle					

Legend	
Area Treatments	
Grazed	
Round-up	
Burned	
Rototilled	
Seeded	
Herbicide	
Mowed	
Biocontrol	

Area C3 - *This area is a subdivision of Shaft Hill. The following are documented actions:*

In 1998, a wildfire burned the lower, flat part of C3 (H4) and part of the north aspect of the hill (H3). Park staff planted this two-acre patch with bluebunch wheatgrass, but most of the replanting failed. It was out-competed by cheatgrass. Yellow starthistle became the dominant weed and has been mowed every summer to cut off seedheads before they mature. Park staff planted the west end of C3 (H4) with great basin wildrye grass and has become an established stand behind the Great Grave and Pioneer Cemetery. Also in 1998 the park bought two biological control agents aimed at yellow starthistle, the yellow starthistle peacock fly (*Chaetorellia australis*) and the yellow starthistle bud weevil (*Bangasternus orientalis*). Park staff distributed the bugs on the west aspect of Memorial Shaft Hill, C3 (H2), in the early summer. Since the spring of 2000, Transline and the biocontrol agents have controlled the yellow starthistle on the west aspect of the hill. (Source: Trick, Roger. WHMI. 2002. Revegetation Updates)

Area C3 (also H2 and H4) – Whitman Mission National Historic Site 1998 - 2002

	1998	2000 (spring/summer) - 2002
Burned by wildfire		
Planted - burned area with Bluebunch wheatgrass		
Planted - west end with Great Basin wild ryegrass		
Biocontrol - to control yellow starthistle		
Mowed - yellow starthistle (summer 1998-2000)		
Biocontrol - to control yellow starthistle		
Herbicide - Transline to control yellow starthistle		

Legend	
Area Treatments	
Grazed	
Round-up	
Burned	
Rototilled	
Seeded	
Herbicide	
Mowed	
Biocontrol	

Area D - *Area D includes approximately 40 acres in the northern most portion of the Park. It has been subdivided into a number of smaller units as described below.*

D1A and D1B

Areas D1a and D1b lie in the northeast corner of Whitman Mission and contain the area that is generally five to six feet lower than the rest of the park. By 1987, these areas were in a relatively stable condition, dominated by reed canary grass. Park staff annually spot sprayed poison hemlock and teasel in these areas to keep them under control. When the park staff mows inside the park boundary fence, they usually mow any teasel and poison hemlock growing in D1b. In 1995, a prescribed fire burned these two areas as well as D2. After this spring burn, park staff spot-sprayed areas of broadleaf weeds. By early summer, the reed canary grass had over-topped any weeds.

Running through Area D1a roughly parallel to its boundary with D2, and approximately 30 feet from it is a secondary Doan Creek channel. It carries water to Mill Creek when the irrigation ditch is closed for repair or cleaning. In 1998, the park staff bought native trees and shrubs to plant along one side of the secondary Doan Creek. Following the recommendations contained in the Doan Creek Restoration Plan written by Inter-Fluve, Inc. in 1995, park staff applied Roundup, then tilled the south side of the channel. Native trees and shrubs were planted approximately three feet apart along almost 300 feet of the bank. Each plant had a vinyl, degradable weed barrier surrounding it. Park staff had to periodically string trim around the new plants during the rest of 1998 and during the growing season of 1999. In 2000 and 2001, the park staff sprayed Roundup around the small plants to control stinging nettle, bull thistle, and canary grass. In general, the canary grass grew so well and so thick that it usually over-topped the native shrubs and trees that had been planted.

It is difficult to predict if any of the plantings will survive being repeatedly over-grown by canary grass. Continued spot spraying will control poison hemlock and teasel. Non-native Russian olive trees are slowly coming into this area and Area D2. While a good wildlife habitat tree, it is a non-native and will have to be controlled within the next few years.

Other Earlier Documented Actions:

Area D1A - *This is a portion of the northern fields and waterways are at the north end of the Park, and is located in the northeast section of Area D.*

1. 1987 Observations by Larry Larson indicate that previous treatment of hemlock and teasel in these areas has greatly reduced the presence of weeds. (Source: Larry Larson. Letter to Roger Trick dated April 9, 1987)
2. 1987-Observations by Larry Larson indicate that treatments recommended in the April 9, 1987 report (Spot treatment with Banvel) was completed and the objective of controlling poison hemlock has been achieved. (Source: Larry Larson. Letter to Dave Herrera dated June 22, 1987)
3. 1995-An Individual Fire Report dated March 27, 1995 documents a prescribed fire of 16 acres in Areas D1A, D1B, D2, and E. (Source: Individual Fire Report dated March 27, 1995)

Area D1B - *This is a portion of the northern fields and waterways area at the north end of the Park.*

1. 1986-Romo recommends Area to be mowed as soon as possible to prevent poison hemlock from setting seed. Notes on this report indicate this was done in the summer of 1986. (Source: Jim Romo. Letter and Report to Robert Amdor dated July 7, 1986)
2. 1987-The following observations for Area D1B are that the previous treatment (spot treatment with Banvel) was completed and has greatly reduced the presence of hemlock and teasel. (Source: Larry Larson. Letter to Roger Trick dated April 9, 1987)
3. 1987-Observations by Larry Larson indicate that treatments recommended in the April 9, 1987 report (Spot treatment with Banvel) was completed and the objective of controlling poison hemlock has been achieved. (Source: Larry Larson. Letter to Dave Herrera dated June 22, 1987)
4. 1995-An Individual Fire Report dated March 27, 1995 documents a prescribed fire of 16 acres in Areas D1A, D1B, D2, and E. (Source: Individual Fire Report dated March 27, 1995)

Area D1A, D1B – Whitman Mission National Historic Site 1986 – 2001

	1986	1987		1995		1998	1999	2000	2001
	Summer	Spring				Spring	Summer	Spring	Summer
Area D1A									
Herbicide - Treatment of Teasel/Hemlock w/Banvel									
Planted - burned area with Bluebunch wheatgrass									
Prescribed fire - burned area									
Roundup applied - south side of channel/tilled									
Plant - native trees/shrubs along tributary to Doan Creek									
Trim - string trim around new plants									
Spot spray - Roundup applied									
Area D1B									
Mowed - to prevent Poison Hemlock from setting seed									
Spot treatment - Banvel to control hemlock									

Legend	
Area Treatments	
Grazed	
Round-up	
Burned	
Rototilled	
Seeded	
Herbicide	
Mowed	
Biocontrol	

Area D2

By 1990, Area D2 had a well-established grass stand. Spot spraying with a broadleaf herbicide controlled spikeweed (tarweed) and yellow starthistle. By 1994, the accumulation of dead grass stems had affected the vigor of the grass stand, and more weeds had invaded. In March 1995, the area was burned when Areas D1a and D1b were burned. This allowed herbicide treatments for broadleaf weeds to reach down to the young weeds and eliminate them while the grasses were in their spring growth.

A triangular portion at the eastern end of D2 had never received seed with the rest of the area in 1987. The result was a triangle about 200 feet on each side that contained spikeweed, kochia, and yellow starthistle. Once the park bought the roto-tiller, park staff sprayed, tilled, and seeded this triangle with bluebunch wheatgrass in 1996.

In March 1998, the park staff and US Forest Service personnel burned Area D2 again, with the same strategy in mind as in 1995. An early spring burn reduced the dead biomass to give the growing plants a nitrogen boost just as they begin to grow. Reducing the standing and accumulated dead grass stems allowed broadleaf spray to reach the early growing weeds and eliminate them. This gave the grass enough time to overtop newly germinating weeds and out-compete them for light and moisture.

The non-historic portion of the Doan Creek channel borders Area D2 on the south. In 1997, park staff planted a dozen willow branches in the ditch bank. In 2002, five of the plants were still growing. In 2000, park maintenance staff roto-tilled and planted the access lane along the Doan Creek channel with streambank wheatgrass. Some of the new grass became established, and is mowed three to five times each summer. Park vehicles use the lane for access to the water channel and the irrigation ditch diversion box at the park's east boundary. It has a mixture of grasses, yellow starthistle and spikeweed growing in the lane and beside it in Area D2.

Other Earlier Documented Actions:

Area D2 - *This is a portion of the northern fields and waterways area at the north end of the Park.*

1. 1985-1986-Romo states that and application of Tordon 22K at ¼ pound active ingredient in Spring of 1985 eliminated yellow starthistle and diffuse knapweed. This unit was burned on June 24, 1986. Prior to burning this area, cheatgrass and pepperweed (*Lepidium perfoliatum*) were the most common species. . (Source: Jim Romo. Letter and Report to Robert Amdor dated July 7, 1986)
2. 1987-Memo states that Area D2 was treated in the past to control knapweed, starthistle and cheatgrass. The area was seeded in the fall of 1986 and has a satisfactory stand of basin wildrye becoming established on the site. (Source: Larry Larson. Memo dated April 9, 1987)
3. 1988-Letter states that the grass stands that were planted last fall (1987) appear to be healthy and should be established by fall. (Source: Larry Larson. Letter, dated April 18, 1988)
4. 1988-Annual Report from 1988 covering the period from April 1987 to December 1988 states that Area D2 had been seeded in the fall of 1986 in an effort to revegetate the area. This seeding was in severe trouble by April of 1987 due to competition by cheatgrass. The area was mowed a number of times during the summer (of 1987) in an effort to save the seeding. The area was burned in late August of 1987 to prepare the seedbed, and sprinkler irrigation was used to simulate 2 inches of precipitation and promote cheatgrass germination. The area was sprayed in mid-September with Roundup (1 pt/A) to control the cheatgrass seedlings. In October, a John Deere Power Seeder was used to seed the area to tall wheatgrass, basin wildrye, pubescent wheatgrass, and bluebunch wheatgrass. This was followed with a broadcast seeding of the area with big bluegrass and Covar sheep fescue. It had a slow rate of establishment in June 1988 because either [1] the grass roots entered a zone of salt accumulation, or [2] the roots entered a zone of Picloram residue. (Source: Larry Larson. Annual Report . 1988. Covers the period from April 1987 through December 1988)

5. 1989-Annual report states that the seeded grass stand is in its second year of establishment, and is developing rapidly. It is composed of tall wheatgrass, Sherman big bluegrass, Secar bluebunch wheatgrass, and basin wildrye. Small patches of cheatgrass and spikeweed exist within the unit. Sherman big bluegrass was broadcast into these areas in November (1989) to speed the replacement of the weed species. (Source: Larry Larson. 1989 Restoration report)
6. 1995-An Individual Fire Report dated March 27, 1995 documents a prescribed fire of 16 acres in Areas D1A, D1B, D2, and E. (Source: Individual Fire Report dated March 27, 1995)

Area D2 – Whitman Mission National Historic Site 1985 – 2000

	1985 Spring	1986 June	1986 Fall	1987 Summer	1987 August	1987 Fall	1989 November	1990 Summer	1995 March	1996	1998	2000
Tordon - applied for starthistle/knapweed												
Area Burned - eliminate cheatgrass/pepperweed												
Area Seeded - with Great Basin Wildrye												
Area Mowed - several times												
Area Burned - to prepare seedbed												
Sprinkler irrigated												
Area Sprayed - with Roundup to control cheatgrass												
Area Seeded - power seeded tall wheatgrass, great basin wildrye, pubescent wheatgrass, bluebunch wheatgrass												
Broadcast seeding - big bluegrass, cover sheep fescue												
Broadcast seeding - Sherman big bluegrass												
Patches of Area spot sprayed - Broadleaf herbicide for tarweed, starthistle												
Area Burned												
Portion of area sprayed, tilled, seeded - with bluebunch wheatgrass												
Area Burned												
Portion of access lane along Doan Creek - rototilled and planted with streambank wheatgrass												

Legend
Area Treatments
Grazed
Round-up
Burned
Rototilled
Seeded
Herbicide
Mowed
Biocontrol
Irrigated

Area D3

Area D3 after two re-plantings finally had an established grass stand in 1990 of tall wheatgrass. Spot spraying Canada thistle and field bindweed occurred in the early 1990s. In the spring of 1993, the park staff and US Forest Service personnel burned the area to re-invigorate the grasses. After the burn, the entire Area D3 received a broadleaf herbicide to control weeds. Spot spraying continued through the mid-1990s while Canada thistle began to invade the area.

In March 1997, Area D3 was burned again, and in some parts of the grass stand the fire was so hot that it killed the entire root wad of the bunchgrass. Canada thistle invaded these open areas (about 20 percent of Area D3). Park staff has been working to reduce the Canada thistle patches in Area D3 since 1997, using spot spraying and "spot mowing".

In 2000, the park staff mowed all of the southern half of D3 and then broadcast sprayed it with a broadleaf herbicide. The staff continued to spot spray Canada thistle, kochia, and poison hemlock on the north half of D3. In the fall, 2001 spot mowing of weedy patches allowed very effective spot spraying in spring, 2002, and reduced the Canada thistle patches by 50 percent. Continued spot spraying and over seeding of tall wheatgrass or great basin wild ryegrass should gradually reduce the thistle.

Other Earlier Documented Actions:

Area D3 - *This is a portion of the northern fields and waterways area at the north end of the Park.*

1. 1986-Romo states that this unit was burned on June 24, 1986. At that time there were localized areas (approximately 20%) that were too green to burn. Application of Roundup and Tordon 22K in spring of 1985 eliminated perennial forbs and quackgrass (*Agropyron repens*) over most of the area. On the southern end of D3 is a localized colony of quackgrass and colonial bentgrass (*Agrotis tenuis*). Field bindweed (*Convolvulus arvensis*) is locally abundant in the northern half of Area D3. Romo recommends this unit should be sprayed immediately with Roundup. Notes in this report indicate this was done. (Source: Jim Romo. Letter and Report to Robert Amdor dated July 7, 1986)
2. 1987-Letter from Larry Larson. Area D3 was sprayed with Roundup in the fall of 1986 prior to seeding, however, the lack of moisture that fall made the application less successful. (Source: Larry Larson. Letter to Roger Trick dated April 9, 1987)

3. 1988-Report from Larry Larson to Ed Starkey. This is the area that was partially roto-tilled last fall (1987), and drilled with tall wheatgrass, pubescent wheatgrass, and basin wildrye. The following species were hand broadcasted: secar bluebunch, Sherman big bluegrass and Covar sheep fescue. (Source: Larry Larson. Project description to Ed Starkey, dated April 28, 1988).
4. 1988 Annual Report covering from April 1987-through December 1988. Area D3 was seeded in 1986 with a mixture of Basin wildrye and bluebunch wheatgrass. However, attempts to control the competing vegetation were unsuccessful. The area was mowed periodically during the summer 1987 to control seed production of weeds, and the seeding was determined to be a failure in late July. The area was sprinkler irrigated in late August to simulate summer rains. This was done to encourage weedy species in an active stage of growth so they could be controlled chemically. In mid-September the area was treated with Roundup to control the weed species. The portion of the area that was dominated by quackgrass and Bermuda grass was tilled in late September to break up soil and expose root systems. In October, the tilled areas were packed and the entire unit was drilled with a mixture of tall wheatgrass, basin wildrye, pubescent wheatgrass and bluebunch wheatgrass, and then the area was broadcast seeded with big bluegrass and sheep fescue. (Source: Larry Larson. Annual Report. 1988 Covers period from April 1987 through December 1988)
5. 1989 Annual Report. Area D3 was seeded in the fall of 1987 and 1988. These areas were broadcast seeded with Sherman big bluegrass in November (1988) to improve grass establishment. The application of Tordon the previous fall (1987) controlled broadleaf competition in this unit. Approximately 80 percent of the area contains a good stand of grass. The reason for the localized failures in this seeding is that the seedbed prescription (tillage) brought grass seed (*Hordeum)* to the surface, where it germinated and competed heavily with the desired grass seedlings. (Source: Larry Larson. Annual Report, 1989)
6. 1997-An Individual Fire Report dated March 25, 1997 documents a prescribed burn of 13 acres in Areas D3 and E. (Source: Individual Fire Report dated March 25, 1997)

Area D3 – Whitman Mission National Historic Site 1985 – 2002

	1985	1986	1986	1986	1987	1987	1988	1990	1993	1997	2000	2001	2002
	Spring	Spring	Summer	Fall	Summer	Fall	Fall						
Sprayed - Roundup and Tordon for quackgrass													
Area Seeded - basin wildrye, bluebunch wheatgrass													
Area Burned													
Area Sprayed - Roundup													
Area Mowed													
Sprinkler irrigated													
Area Rototilled													
Area Sprayed - Roundup and Tordon													
Area Seeded - drilled the tilled areas with tall wheatgrass, basin wildrye, pubescent wheatgrass, bluebunch wheatgrass,													
Broadcast seeding - big bluegrass, sheep fescue													
Broadcast seeding - Sherman big bluegrass													
Spot Spraying - Canada thistle, field bindweed (early to mid-1990's, 1997-2002)													
Planting - tall wheatgrass													
Area Burned													
Spot Mowing - Canada Thistle (1997-2002)													
Sprayed - south half of area with broadleaf herbicide													
Mowed -south half of area													

Legend
Area Treatments
Grazed
Round-up
Burned
Rototilled
Seeded
Herbicide
Mowed
Biocontrol
Irrigated

Area D4

In the northwest corner of the park and hidden by trees, Area D4 has low visibility and the park natural resources program tends to neglect it. Failure to follow earlier spraying, mowing, and seeding recommendations resulted in dense populations of poison hemlock, kochia, and spikeweed. It is not possible to get power equipment over Mill Creek, so all work must use only hand-carried, small power tools or hand tools. No prescribed fire has occurred in any part of D4 since 1987. In the early and mid-1990s, part of D4c received a spot spray application of a broadleaf herbicide, but no consistent effort occurred to combat non-native plants.

In 1997, the Natural Resources Conservation Service (NRCS) installed rock barbs along the south bank of Mill Creek as it turns toward the west. In late summer, 1997 the NRCS planted native shrubs and tree seedlings in the rocky area where their earlier work had killed the plants adjacent to Mill Creek. Very few plants survived, despite using weed control blankets and giving them supplemental water. The NRCS over seeded the impacted part of D4c with native grasses at the same time, but by 2002, the area was a mix of native and non-native plants.

In 2002, the park released approximately 250 defoliating hemlock moth caterpillars into a dense poison hemlock patch in D4b. Poison hemlock covers almost all the area of D4b and D4a. The park resources management program plans no other effort for these areas northwest of Mill Creek, so the success of the defoliating moth and its ability to reduce poison hemlock should be easy to monitor over the next few years. Broadcasting native grass seed into these areas may be possible eventually. (Source: Trick, Roger. WHMI. 2002. Revegetation Updates)

Other Earlier Documented Actions:

Area D4A - *This area is a portion of the northern fields and waterways area at the north end of the Park, and is located in the northwest corner, adjacent to Mill Creek.*

1. 1987. Jim Romo recommended Unit D4A should be burned in early spring of 1987. This was done (Personal communication: Roger Trick, 2002). (Source: Jim Romo. Letter and report to Robert Amdor, dated July 7, 1986)
2. 1987- An Individual Fire Report dated March 9, 1987 documents a prescribed burn of 2 acres in Areas D4A and D4B. (Source: Individual Fire Report dated March 9, 1987)

Area D4B-*This area is a portion of the northern fields and waterways area, at the northwest corner of the park.*

1. 1986-Report from Jim Romo recommends area be burned in early spring of 1987, and that Banvel be applied while poison hemlock and teasel are in the rosette stage in spring of 1987. This was done (Personal communication: Roger Trick, 2002). (Source: Jim Romo. Letter and report to Robert Amdor, dated July 7, 1986)
2. 1987. An Individual Fire Report dated March 9, 1987 documents a prescribed burn of 2 acres in Areas D4A and D4B. (Source: Individual Fire Report dated March 9, 1987)

Area D4C- *This is a portion of the northern fields and waterways area at the north end of the Park.*

Romo recommends that Area D4C be mowed as soon as possible to limit seed production by poison hemlock, teasel (*Dipsacus sylvestris*), and yellow starthistle. Notes on the report indicate this was done, confirmed by personal communication: Roger Trick, 2002. (Source: Jim Romo. Letter and Report to Robert Amdor dated July 7, 1986)

Area D4A, D4B, D4C – Whitman Mission National Historic Site 1985 – 2002

	1986	1987	1990	1995	2002
		Spring			
Area D4a					
Area Burned					
Area D4b					
Area Burned					
Sprayed - with Banvel					
Released - 250 defoliating hemlock moth caterpillars					
Area D4c					
Area Mowed - limit seed production of poison hemlock, teasel, star thistle					
Spot spraying - with broadleaf herbicide					

Legend
Area Treatments
Grazed
Round-up
Burned
Rototilled
Seeded
Herbicide
Mowed
Biocontrol
Irrigated

Area E - *This land was initially described as the center of the Park, which would include the visitor center, roads, and parking area. Later maps, however, indicate that the new Area V includes the Visitor Center and roads. These later maps show Area E as between the Visitor's Center and the maintenance buildings.*

Overview and Recent Activities:

By 1990, Area E had a well-established stand of great basin wild ryegrass. The only problem patch was in the northeast corner of Area E where park staff spot mow kochia and Canada thistle every year. In 1995, the park staff used Roundup to create two small (approximately 200 square feet each) areas for growing forbs. The goal was to grow them thick enough to transplant into other areas of the park. At the extreme southern tip of Area E, nearest the Visitor Center, a patch of Canada thistle out-competed the forbs and dominated the patch. The park staff is still spot spraying this patch in 2002 to control the thistles. The other area for forbs was next to the visitor trail leading to the Great Grave, slightly below the Doan Creek channel. Forb seed planted in 1995 grew very well in 1996. A combination of burlap bags between the forbs reduced weed competition by acting as a mulch. Careful spot spraying supplemented the non-chemical weed control.

US Forest Service fire management personnel burned the entire Area E in spring 1997 and then broadcast sprayed for broadleaf weeds. The only area not sprayed was the forb "nursery". By 1998, great basin wild ryegrass dominated the forbs, and the park staff decided to stop spraying Roundup to stem the invasion of the native wildrye into the forb patch. The last prescribed fire in Area E was in March 1999. After the burn, park staff sprayed broadleaf weeds as the grass began growing in March and April. Since then, spot spraying has kept yellow starthistle and kochia under control. (Source: Trick, Roger. WHMI. 2002. Revegetation Updates)

Other Earlier Documented Actions:

1. 1986-An Individual Fire Report dated March 11, 1986 documents a prescribed burn of 10 acres in Areas E and F1. (Source: Individual Fire Report dated March 11, 1986.)
2. 1986. Romo states that this unit was burned in spring of 1986 and localized patches of cheatgrass were burned on 24 June 1986. Recommendations: The eastern and upper portion of this unit where successfully burned should be lightly scarified in Fall 1986 and Magnar Basin wildrye planted. This unit should be mowed at a height of approximately 4

to 6 inches in early June 1987. Unit E should not be grazed or burned for at least 3 years following seeding. These recommendations were implemented: Personal communication, Roger Trick, 2002. (Source: Jim Romo. Letter and Report to Robert Amdor dated July 7, 1986)

3. 1988-Report from Larry Larson summarized trips to Mission between February 25 and April 13,1988. Noted that grass seedlings approximately 1-2 inches in height were observed on all areas that had been seeded in the fall (of 1987). Recommended that Areas E (and F) be burned or mowed. These recommendations were implemented: Personal communication, Roger Trick, 2002. Source: Larry Larson. Report to Ed Starkey dated April 18, 1988; Whitman Mission restoration work)
4. 1988-Report from Larry Larson proposes spot spraying of Area E with Banvel or 2,4-D depending on species in the summer of 1988, in preparation for fall seeding. These recommendations were implemented: Personal communication, Roger Trick, 2002. (Source: Larry Larson. Project description dated April 28, 1988 on the Whitman Mission spray program.)
5. 1989-1990-This prescription applies to 7 acres between the visitor center and the maintenance complex, and various areas around the park that were not treated during phase 1. These areas were tilled in October (1989) and will be checked for annual weed invasion in February. If annual weeds are present the area will be sprayed with Roundup at a rate of 1 pt/A. The area will be drilled and broadcast seeded in late February or early March. The drill seed mix for the low sites will consist of Magnar basin wildrye, Secar bluebunch wheatgrass, and Whitmar bluebunch wheatgrass. The upper areas will be drilled with a mixture of Secar bluebunch wheatgrass, Whitmar bluebunch wheatgrass, and Critana thickspike wheatgrass. Then the entire area will be broadcast seeded with a mixture of Sherman big bluegrass and Covar sheep fescue. These recommendations were carried out: Personal Communication, Roger Trick, 2002. (Source: Larry Larson. Whitman Mission Restoration Annual Report; 1989. Received WHMI Dec. 20 1989.)
6. 1995-An Individual Fire Report dated March 27, 1995 documents a prescribed fire of 16 acres in Areas D1A, D1B, D2, and E. (Source: Individual Fire Report dated March 27, 1995)

7. 1997-An Individual Fire Report dated March 25, 1997 documents a prescribed burn of 13 acres in Areas D3 and E. (Source: Individual Fire Report dated March 25, 1997)
8. 1999-An Individual Fire Report dated March 11, 1999 documents a prescribed burn of 10 acres in Areas E and F1. (Source: Indivudal Fire Report dated March 11, 1999)

Area E – Whitman Mission National Historic Site 1985 – 2002

	1986 Spring	1986 Fall	1987 Spring	1988 Spring	1988 Summer	1989 Fall	1990 Late Winter	1990 Early Spring	1995	1997 Spring	1999	2002
Area Burned												
Area Scarified												
Area Planted - Magaar Basin Wildrye												
Area Mowed												
Area Mowed/Burned												
Spot Sprayed - Banvel/2 A-D												
Area Rototilled												
Area Sprayed - Roundup												
Area Seeded - drilled/broadcast seeded Magaar basin wildrye, Secar bluebunch wheatgreass. Whitmar bluebunch wheatgrass, critania thickspike wheatgrass												
Broadcast seeding - Sherman big bluegrass, Covar sheep fescue												
NE Corner - spot mowing of kochia (1990 - annually)								sp/summer 1990-2002				
Spot Spraying - two small areas (200 sq. ft.) sprayed with Roundup for growing forbs												
Forb cereal planted - growing well into 1996												
Burlap bags - placed to act as weed preventing mulch												
Spot Spraying - control weeds in forb areas (Canada thistle) 1995-2002									sp/summer 1995-2002			
Area Burned - by USFS (Spring 1997)												
Area Sprayed - broadleaf herbicide												
Area Burned - prescribed fire												
Area Sprayed - broadleaf herbicide												
Area spot sprayed - yellow starthistle, kochia - annually since 1999 spring/summer												

Legend
Area Treatments
Grazed
Round-up
Burned
Rototilled
Seeded
Herbicide
Mowed
Biocontrol
Irrigated

Area F - *This area is the historic core of the park.*

Overview and Recent Actions:

Area F1 - *This land constitutes a sub-unit of the historic core of the Park. The following are documented actions:*

After seedbed preparation in the fall of 1990, discontinuous parts of Area F1 were planted in March 1991. Spring plantings never seem to be as successful as autumn ones, and that was the situation in F1. The goal was to create a patchwork of different grasses, based on the historic soil moisture in different parts of Area F1. Most grasses became established, although there have always been patches of poison hemlock, wild (China) lettuce, quackgrass, and other non-native plants.

During most of the 1990s after the planting in 1991, the park staff spot sprayed patches of poison hemlock and other broadleaf weeds. Most of those years the staff flail mowed around the south and west sides of the grove of silver poplar trees at the interpretive demonstration area below the Great Grave. Park staff would mow other weedy patches in F1 at the same time.

In 1995, the park started a forb nursery in Area F1 directly south of the Visitor Center. Yarrow seemed to grow best. Weed control around the forbs patch, and in between the flowers, required a significant amount of labor. Using burlap bags as mulch to block weeds, and carefully spot spraying continued for a few years. By 1998, grasses had invaded the forb patch and out-competed the forbs. Park staff decided to abandon the patch as a forb nursery.

In March, 1999 Area F1 was burned the same time Area E was. Since then spot spraying for broadleaf weeds such as poison hemlock, wild lettuce, and bedstraw occurs every year. A few yarrow plants still produce flowers near the forb nursery.

Other Earlier Documented Actions:

1986-Report from Jim Romo states this unit was burned in spring of 1986. He recommends that localized colonies of Canada thistle (*Cirsium arvense*) should be mowed to prevent seed production. Notes on the report indicate this was done. This area should not be burned until early spring 1989. A 3-year period between fires will allow perennial grasses to express their competitive ability against weeds. Localized colonies of Canada thistle (*Cirsium arvense*) should be mowed to prevent seed production and then treated in fall of 1986 and spring

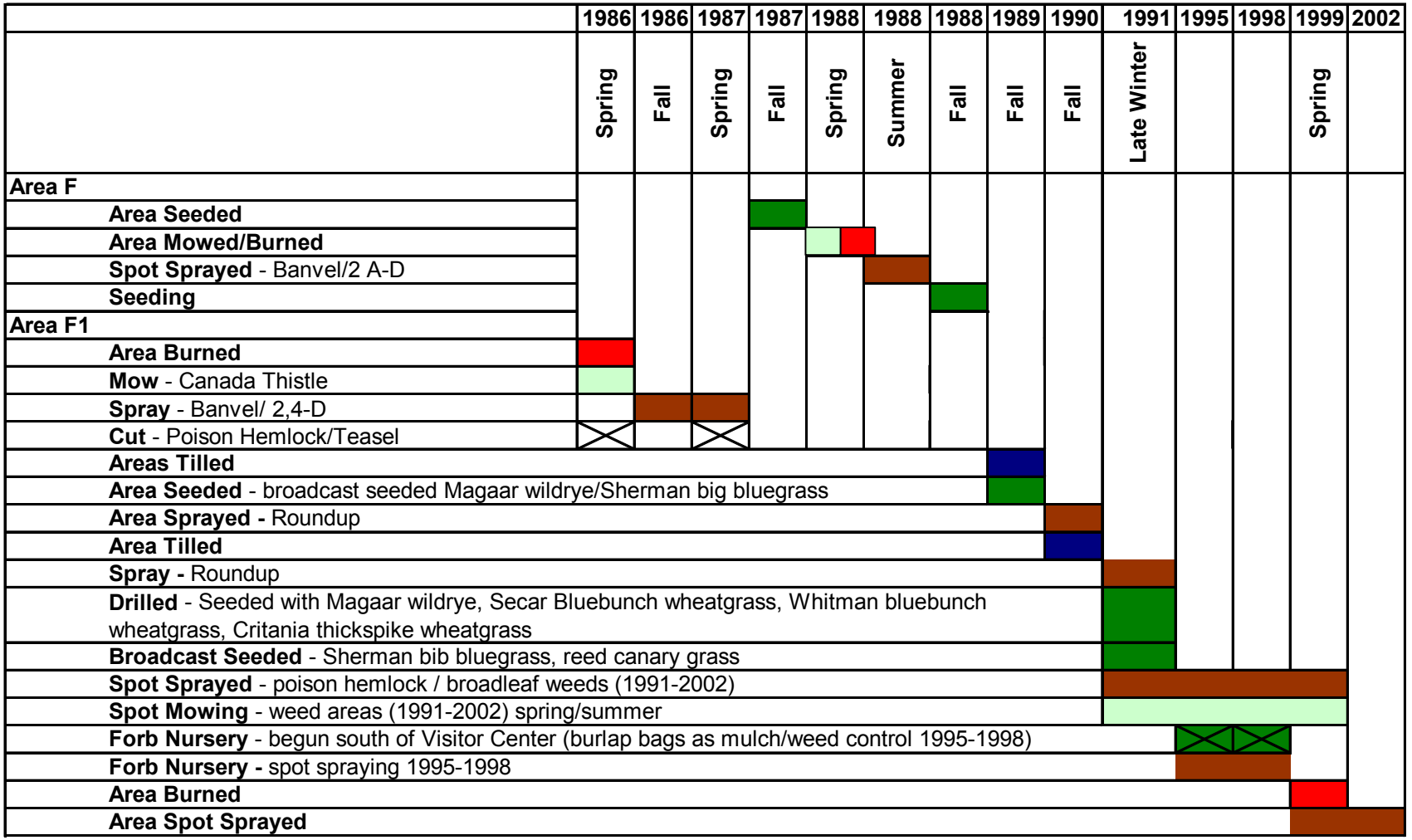
of 1987 with Banvel or 2,4-D. These herbicide applications should reduce the vigor of Canada thistle and allow the perennial grasses to invade and compete with it. Poison hemlock and teasel are present near the Old Oregon Trail; these weeds should be cut at ground level in 1986 and 1987 and removed before they set seed. Preventing seed production and removal of teasel and poison hemlock will enable the perennial grasses to grow, compete, and suppress these weedy species. These recommendations were implemented: Personal communication, Roger Trick, 2002. (Source: Jim Romo. Letter and report to Robert Amdor, WHMI, dated July 7, 1986. Report is A Survey of the Restoration Efforts at Whitman Mission National Historic Site and Recommendations for Continued Success.)

1. 1986-An Individual Fire Report dated March 11, 1986 documents a prescribed burn of 10 acres in Areas E and F1. (Source: Individual Fire Report dated March 11, 1986.)
2. 1989 Annual Report from Larry Larson. Portions of the fescue field (2 acres) were prepared for conversion from tall fescue to a mixture of basin wildrye, big bluegrass, and native forbs. Areas within the field were sprayed (September) with Roundup at a rate of 1 qt/A to create irregular islands within the tall fescue grass stand. These islands were tilled in October and broadcast seeded (30 lbs/A) in November with Magnar wildrye (80%) and Sherman big bluegrass (20%). Patches within the islands were flagged and planted with various mixtures of native forb and shrub species. These actions were completed. Personal communication: Roger Trick, 2002. (Source: Larry Larson. Whitman Mission Restoration Annual Report: 1989. Received WHMI Dec. 20, 1989.
3. 1990-Letter from Larry Larson making observations about Area F1: A native grass seeding is scheduled to occur on the fescue field. The field needs to be placed on a seedbed preparation schedule that will permit seeding (drill) next March. This will require the eradication of existing vegetation. The best option for achieving this goal will be to spray the field with Roundup at a rate of 1 qt./A applied in September when the plants are in fall re-growth. After 2 weeks the field should be tilled, except for exiting islands of native vegetation. The field should be monitored in February to determine if the application of 1 pt/A will be necessary for weed control prior to seeding. The drill mix will consist of Magnar basin wildrye, Secar bluebunch

wheatgrass, Whitmar bluebunch wheatgrass, and Critana thickspike wheatgrass. A broadcast seeding will follow applying Sherman big bluegrass to upland sites and reed canarygrass to the wettest areas. These recommendations were implemented: Personal communication, Roger Trick, 2002. (Source: Larry Larson. Letter to Terry Darbey WHMI dated August 13, 1990. Subject Whitman Mission Vegetation Maintenance Program [3 year]).

4. 1990-Annual Report. A second native grass seeding (drill) is scheduled for the fescue field (Figure 2:Unit F1) in March 1991. The field was tilled in the fall of 1990 and will be left fallow until 2-3 weeks prior to the seeding. At that time the field will be evaluated to determine areas requiring an application of Roundup (1 qt/A) to control volunteer quackgrass and tall fescue. The field will be planted with a number of seed mixes in order to establish a mosaic of native plant communities. A reed canarygrass seed mix will be seeded in the wettest areas of the field with basin wildrye seed mixes planted in the remaining lowland sites. Upland areas and stringer communities will be established with big bluegrass and bunchgrass wheatgrass seed mixes to complement the community mosaic and blend this seeding with the 1990 native seedings on the miscellaneous area. The island seedings established in the fescue field in 1990 (1989 annual repot) were saved and incorporated into the community mosaic. These recommendations were implemented: Personal Communication, Roger Trick. 2002. (Source: Larry Larson. Annual Report, 1990. Whitman Mission Restoration Project.)
5. 1999-An Individual Fire Report dated March 11, 1999 documents a prescribed burn of 10 acres in Areas E and F1. (Source: Individual Fire Report dated March 11, 1999)

Area F and F1 – Whitman Mission National Historic Site 1986 – 2002



Legend
Area Treatments
Grazed
Round-up
Burned
Rototilled
Seeded
Herbicide
Mowed

Area F2

This area contains the irrigated turf that surrounds the original Whitman buildings. Around the periphery of this area are patches of weeds and native grasses.

In 1987, park maintenance staff sprayed with Roundup and then seeded with grasses the area between the Mill Pond and Area B. Since then the park staff has mowed this area in back of the pond every year about once a month, and spot sprayed for broadleaf weeds a couple times each growing season.

In 1995, the park staff worked to improve the historic irrigation ditch that flows through F2 near the Oregon Trail. Every few years the park staff would divert the water flow and then manually remove vegetation growing in the bottom of the ditch. Right afterward in 1995 a ditch liner was installed to prevent regrowth of reed canary grass and other plants in the ditch bottom. The liner has also helped with erosion control along the south side of the irrigation ditchbank. Since 1995, the liner has not prevented clumps of canary grass from growing in pockets of deposited soil; it just makes it much easier to remove those plants.

In the same year, Boy Scouts planted small one-and two-gallon sized native shrubs and trees between the Millpond and the Oregon Trail. Based on recommendations from the Doan Creek Restoration Plan by Inter-Fluve, Inc., the Scouts surrounded each plant with a weed prevention blanket three feet on a side and seeded the areas between the weed blankets with native grass seed. Weeds quickly came to dominate this area, and park staff could not spray herbicides for fear of killing the newly planted shrubs. Park staff string trimmed most of the area and probably string trimmed the tops of many of the newly planted shrubs. The park deemed the effort a failure by 1997 and the goal in this area has been to control broadleaf weeds and encourage grasses since then. Park staff sowed native grass seed the entire length of the area between the irrigation ditch and the Oregon Trail. By 2002, the predominant plants in this area are great basin wild ryegrass, poison hemlock, and canary grass.

In September 2002, a one-quarter acre patch was sprayed with Roundup, tilled, and then hydro-seeded with Sodar streambank wheatgrass. The grass has grown very well and will receive irrigation water when the rest of the Mission Grounds does during the 2003-growing season. In 2003, another one-quarter to one-half acre patch of the Mission Grounds is scheduled for conversion to streambank wheatgrass. These small steps are the prototype to revegetating the Mission Grounds to a species that is native, that prevents erosion and withstands visitor use, and

can assist with the General Management Plan goal of improving interpretation on the Mission Grounds. (Source: Trick, Roger. WHMI. 2002. Revegetation Updates)

Other Earlier Documented Actions:

1. 1988-Report from Larry Larson summarized trips to Mission between February 25 and April 13,1988. Noted that grass seedlings approximately 1-2 inches in height were observed on all areas that had been seeded in the fall (of 1987). Recommended that Areas E and F be burned or mowed. These recommendations were implemented: Personal communication, Roger Trick, 2002. Source: Larry Larson. Report to Ed Starkey dated April 18, 1988; Whitman Mission restoration work)
2. 1988-Report from Larry Larson proposes spot spraying of Areas E and F with Banvel or 2,4-D depending on species in the summer of 1988, in preparation for fall seeding. These recommendations were implemented: Personal communication, Roger Trick, 2002. (Source: Larry Larson. Project description dated April 28, 1988 on the Whitman Mission spray program.)
3. 1986 This report from Jim Romo to the Superintendent in 1986 contains observations and recommendations for Area F2: The area north, south, and east of the intensively managed turf in Unit F2 should be burned as early as possible in spring of 1987. This burning will enhance the vigor of perennial grasses and suppress weedy species. Within Unit F2 are localized colonies or Canada thistle. After prescribed burning, these Canada thistle colonies should be sprayed with Banvel or 2,4-D. The release of grasses by burning and the suppression of Canada thistle with herbicides should result in improved perennial grass cover and reduced weed densities. These recommendations were implemented: Personal communication, Roger Trick, 2002. (Source: Jim Romo. Letter and report to Robert Amdor, WHMI, dated July 7, 1986. Report is A Survey of the Restoration Efforts at Whitman Mission National Historic Site and Recommendations for Continued Success.)
4. 1989-1990. These recommendations apply to the pond which is in Area F2. The pond unit contains two management areas; [1] the west side of the pond that was seeded last year and will receive intensive management because it is next to the lawn, and [2] the east side of the pond which will be maintained in a natural condition and has not

received any restoration treatments. The west side of the pond was broadcast seeded with Sodar streambank wheatgrass and Sherman big bluegrass after the pond bank was reconstructed. Four clumps of rush/bulrush sod were planted at the water's edge last fall. An acceptable grass stand became established on the pond bank and should continue to occupy the site. This grass stand contains areas of Italian ryegrass, Kentucky bluegrass, and Bermuda Grass (lawn grasses) which have become established in the openings of the native grass stand. At the waters' edge the transplants of rush/bulrush sod have become established and should spread along the pond boundary. The east side of the pond is benefiting from the seed drop occurring in Area B along the old river channel. Reed Canarygrass and rushes are moving into this area. In addition, native species of goldenrod, smartweed, and cattail are growing on the site. I recommend that the area be broadcast seeded in February with reed canarygrass and Sherman big bluegrass with follow-up spot treatments of herbicides in the spring to encourage the process of natural succession. These recommendations were carried out: Personal Communication, Roger Trick, 2002. (Source: Larry Larson. Whitman Mission Restoration Annual Report: 1989. Received, WHMI Dec. 20, 1989.)

Area F2 – Whitman Mission National Historic Site 1987 – 2002

	1987	1988	1990	1995	1997	2002
	Spring	Spring	Late Winter			Fall
Area Burned						
Area Sprayed - Banvel/2-4,D for thistles						
Area Mowed - back of pond for weeds 1987-2002						
Spot spray - broadleaf weeds 1987-2202						
Seeded - west side of pond seeded to Sodar streambank wheatgrass, Sherman big bluegrass						
Broadcast seeded - reed canary grass, Sherman big bluegrass						
Spot spray - herbicide treatment						
Native plants/trees - Boy scouts planted between millpond and Oregon Trail						
String trimming weeds around shrubs/trees						
Seeded - native grasses between irrigation ditch and Oregon Trail						
Sprayed - 1/4 acre patch sprayed with Roundup						
Rototilled - 1/4 acre patch rototilled						
Hydroseeded - 1/4 acre patch hydroseeded with Sodar streambank wheatgrass						

Legend
Area Treatments
Grazed
Round-up
Burned
Rototilled
Seeded
Herbicide
Mowed
Biocontrol
Irrigated

Area G - *This area is a 500 square foot nursery set aside within the fescue field. It was begun, but not completed. It was not successful enough that plants here could be transplanted to other areas.* Personal communication, Roger Trick, 2002.

Overview and Recent Activities:

Area G was the designation for the small patches taken out of Area F1 and then planted with native forbs. These patches were covered under the summary of Area F1. (Source: Trick, Roger. WHMI. 2002. Revegetation Updates)

Other Earlier Documented Actions:

1. 1990-An area of 500 sq. ft. will be set aside in the fescue field as a nursery for the establishment of native forbs and shrub species. The area will be used to germinate and establish plants that can be transplanted the following fall or spring. Seeds purchased in 1990 will be used to initiate this program next spring. This project was begun, but not completed. It was not successful enough that plants here could be transplanted to other areas. Personal communication, Roger Trick, 2002. (Source: Larry Larson. Letter to Terry Darbey dated August 13, 1990. Subject Whitman Mission Vegetation Maintenance Program.)
2. 1990- An area of 500 sq ft will be set aside in the fescue field to establish a native forb and shrub garden (figure 2: Area G). The area will need to receive intensive weed management and be used to develop transplant stock for native forb and shrub species. Seeds purchased in 1990 will be used to initiate this program in March 1991. The garden will be used for a minimum of 4 years. This recommendation was initiated, but not successfully enough to develop transplant stock: Personal Communication, Roger Trick. 2002. (Source: Larry Larson. Annual Report, 1990. Whitman Mission Restoration Project.)

Area H - *This area, its subdivisions are interspersed with Area C and its subdivisions on Shaft Hill. Where recommendations and actions were carried out in the area described as "The Hill", these will be listed under the respective Areas C and H.*

Overview and Recent Activities:

The Memorial Shaft Hill poses special difficulties to restoration because of its steep slopes and generally dry environment. In the early 1990s, yellow starthistle became the dominant plant on the south and west aspects and the flat top of the hill. Cheatgrass was the predominant grass. After the wildfire in 1988, the south aspect of the hill was hydroseeded in the fall of 1989 with Sherman big bluegrass. The fire had not burned enough cheatgrass stems to produce bare ground. The result was that the hydroseeded material did not have good enough contact with the soil, so that while germination was good, actually getting the grass plant to grow was a failure. Cheatgrass and yellow starthistle continued to dominate the slope, and the park staff considered the effort a failure.

Ever since the early 1990s, the park staff used broadleaf herbicides along the eastern part of Area C. This provided a 20-30 foot buffer between the park land, which was heavily infested with yellow starthistle, and the neighbors' land. In addition, the park staff would hand pull or string trim cereal rye grass (*Secale cereale*) within the same buffer area before the seed heads were mature. This satisfied the neighboring farmers concerns about these weeds entering their commercial wheat fields.

A graduate student from Oregon State University, Roger Sheley, used about one acre on top of the hill for research plots in 1992. As part of his dissertation research, he studied the growth of yellow starthistle and cheatgrass under different environmental conditions and at different plant densities. The park staff was able to take some of his research findings and use them to help control yellow starthistle.

After broadcast spraying the top of the hill (H6) with a general herbicide, the park planted it with bluebunch wheatgrass and other native grasses in 1991. The grasses established themselves over a few years and by the mid-1990s, the top of Memorial Shaft Hill had a good stand of grass that required only spot spraying to control the yellow starthistle.

In 1998, a wildfire burned the lower, flat part of C3 (H4) and part of the north aspect of the hill (H3). Park staff planted this two-acre patch with bluebunch wheatgrass, but most of the

replanting failed. It was out-competed by cheatgrass. Yellow starthistle became the dominant weed and has been mowed every summer to cut off seedheads before they mature. Park staff planted the west end of C3 (H4) with great basin wildrye grass and a stand has become established behind the Great Grave and Pioneer Cemetery.

On the recommendation of the county weed control officer, the park applied a different herbicide in 1998 to control yellow starthistle. The herbicide Transline is expensive, but it is effective. It was used first on Area C2 (H5). On the south aspect of the hill in September, 1998, a prescribed fire got out of control and burned almost all of C2 (H5) and a small area of C1 (H6). The prescribed burn was to prepare the area for vegetation plugs to be planted later that fall. Park staff and volunteers planted the grass plugs in October 1998 along the top of the slope and at the bottom near the boundary fence. In early spring, 1999, the same area of the hill was hydroseeded with bluebunch wheatgrass and sheep fescue. The spring and summer of 1999 were warm and dry, and most of the plugs did not survive the summer. Only a small percentage of the hydroseeded area grew grass that survived into the fall. The south aspect of the hill, C2 (H5) contains scattered snow buckwheat, lupine, and a few native grasses. Cheatgrass is the predominant plant.

In 1998 the park bought two biological control agents aimed at yellow starthistle, the yellow starthistle peacock fly (*Chaetorellia australis*) and the yellow starthistle bud weevil (*Bangasternus orientalis*). Park staff distributed the bugs on the west aspect of Memorial Shaft Hill, C3 (H2), in the early summer. Since the spring of 2000, Transline and the biocontrol agents have controlled the yellow starthistle on the west aspect of the hill.

Since 2000, park staff has spot sprayed yellow starthistle on all areas of Memorial Shaft Hill, and kept it under control. Since then, more lupine has been spreading in C2 (H5) and C1 (H6). Park staff may experiment with a new control agent for yellow starthistle. Some research indicates that vinegar, when sprayed on immature plants, will kill up to 90 percent of a yellow starthistle stand. Whitman Mission staff may use this as a spot spray technique and monitor its effectiveness. (Source: Trick, Roger, WHMI. 2002. Revegetation Updates)

Other Earlier Documented Actions:

1. 1989-90 A four-acre area of the hill (specific area not identified) will be revegetated in late February or early March, 1990. The area includes the area that was accidentally burned last year (south aspect) and a section of land on top of the hill. The top of the hill will be burned in an irregular pattern this fall. In February the burned area and the south aspect will be sprayed with Roundup at the rate of 1 pt/A to clear the area of annual grass competition. Both areas will be broadcast seeded (30 lbs/A) and mulched with clean straw (minimal weed and wheat seed) at the rate of 500 lbs/A. The seed mix will consist of Sherman big bluegrass, Critana thickspike wheatgrass, Secar bluebunch wheatgrass, Sodar streambank wheatgrass, and sand dropseed. A spring application of Glean will probably be required to control yellow starthistle seedlings in the seeding. These recommendations were carried out: Personal Communication, Roger Trick, 2002. (Source: Larry Larson. Whitman Mission Restoration Annual Report; 1989. Received WHMI Dec. 20, 1989.)

2. 1990 Letter from Larry Larson observes that the Hill (Units H1-H6) represents a harsh environment with numerous exotic weed species. Unit H5 was seeded last Feb/Mar and has grass seedlings growing on the area. These seedlings are not established and will require the completion of the 1991 growing season before the quality of the grass can be assessed. As an insurance policy I propose that we broadcast seed ½ of this unit in the fall to determine if a double seeding will improve the quality of grass stand in 1991. Units H1 and H6 should be burned this fall to remove weed residue, and help prepare the seedbed. The units will be monitored in February to determine when and application of 1 pt/A of Roundup should be applied to control annual weeds. Unit H6 will be drilled in March with Secar and Whitmar bluebunch wheatgrass, and Nezpar Indian ricegrass. This will be followed with a broadcast seeding of Sherman big bluegrass, Covar sheep fescue, and sand dropseed. Unit H1 will be broadcast seeded with a similar seed mix followed with a straw mulch. If a grass stand begins in the spring and is threatened by weed encroachment it may be necessary to control weeds with Glean. The cost of spraying with Glean will be the loss of perennial buckwheat plants that currently occupy portions of the hill. (The recommendations were implemented. Personal Communication: Roger Trick, 2002) (Source: Larry Larson. Letter to Terry Darbey dated August 13, 1990. Subject Whitman Mission Vegetation Maintenance)

Area H1 - *Area H1 is in the center portion of Shaft Hill. The following is a documented action:*

Letter from Larry Larson (1990) observes that the Hill (Units H1-H6) represents a harsh environment with numerous exotic weed species. Units H1 and H6 should be burned this fall to remove weed residue, and help prepare the seedbed. The units will be monitored in February to determine when and application of 1 pt/A of Roundup should be applied to control annual weeds. Unit H1 will be broadcast seeded with a similar seed mix followed with a straw mulch. If a grass stand begins in the spring and is threatened by weed encroachment it may be necessary to control weeds with Glean. The cost of spraying with Glean will be the loss of perennial buckwheat plants that currently occupy portions of the hill. (The recommendations were implemented. Personal Communication: Roger Trick, 2002) (Source: Larry Larson. Letter to Terry Darbey dated August 13, 1990. Subject Whitman Mission Vegetation Maintenance)

Area H2 - *This is the western portion of Shaft Hill. The following is a documented action:*

In 1998 the park bought two biological control agents aimed at yellow starthistle, the yellow starthistle peacock fly (*Chaetorellia australis*) and the yellow starthistle bud weevil (*Bangasternus orientalis*). Park staff distributed the bugs on the west aspect of Memorial Shaft Hill, C3 (H2), in the early summer. Since the spring of 2000, Transline and the biocontrol agents have controlled the yellow starthistle on the west aspect of the hill. (Source: Trick, Roger. WHMI. 2002. Revegetation Updates)

Area H3 - *This is northeast portion of Shaft Hill. The following is a documented action*:

In 1998, a wildfire burned the lower, flat part of C3 (H4) and part of the north aspect of the hill (H3). Park staff planted this two-acre patch with bluebunch wheatgrass, but most of the replanting failed. It was out-competed by cheatgrass. Yellow starthistle became the dominant weed and has been mowed every summer to cut off seedheads before they mature. Park staff planted the west end of C3 (H4) with great basin wildrye grass and has become an established stand behind the Great Grave and Pioneer Cemetery. (Source: Trick, Roger. 2002. Revegetation Updates)

Area H, H1, H2, H3 – Whitman Mission National Historic Site 1988 – 2002

	1988	1990	1990	1991	1998	1999	2000	2001	2002
	Summer	Fall	Late Winter	Late Winter					
Area H									
Wildfire Burned									
Hydroseeded - big bluegrass									
Area Sprayed - Roundup									
Seeded - Sherman big bluegrass, Citania thickspike wheatgrass, Secar Blurbunch									
Sprayed - Glean for starthistle									
Area H1									
Area Burned									
Sprayed - with Roundup									
Seeded - bluegrass, wheatgrass, dropseed									
Spray - Glean for weeds									
Area H2 (also part of C3)									
Biocontrol agents released to control yellow star thistle									
Biocontrol agents released to control yellow star thistle (1998-2002)									
Transline Herbicide Spray (1998-2002)									
Area H3									
Wildfire Burned Area									
Planted Area - bluebunch wheatgrass									

Legend Area Treatments
Grazed
Round-up
Burned
Rototilled
Seeded
Herbicide
Mowed
Biocontrol
Irrigated

Area H4 - *This is the northeast most part of Shaft Hill. The following is a documented action:*

In 1998, a wildfire burned the lower, flat part of C3 (H4) and part of the north aspect of the hill (H3). Park staff planted this two-acre patch with bluebunch wheatgrass, but most of the replanting failed. It was out-competed by cheatgrass. Yellow starthistle became the dominant weed and has been mowed every summer to cut off seedheads before they mature. Park staff planted the west end of C3 (H4) with great basin wildrye grass and has become an established stand behind the Great Grave and Pioneer Cemetery. (Source: Trick, Roger. 2002. Revegetation Updates)

Area H5 - *This is the southern aspect of Shaft Hill. The following are documented actions:*

1. 1990 The letter makes observations and recommendations regarding Unit H5: 1990 Letter from Larry Larson observes that the Hill (Units H1-H6) represents a harsh environment with numerous exotic weed species. Unit H5 was seeded last Feb/Mar and has grass seedlings growing on the area. These seedlings are not established and will require the completion of the 1991 growing season before the quality of the grass can be assessed. As an insurance policy I propose that we broadcast seed ½ of this unit in the fall to determine if a double seeding will improve the quality of grass stand in 1991. (The recommendations were implemented. Personal Communication: Roger Trick, 2002) (Source: Larry Larson. Letter to Terry Darbey dated August 13, 1990. Subject Whitman Mission Vegetation Maintenance)
2. 1998-On the recommendation of the county weed control officer, the park applied a different herbicide in 1998 to control yellow starthistle. The herbicide Transline is expensive, but it is effective. It was used first on Area C2 (H5). On the south aspect of the hill in September, 1998 a prescribed fire got out of control and burned almost all of C2 (H5) and a small area of C1 (H6). The prescribed burn was to prepare the area for vegetation plugs to be planted later that fall. Park staff and volunteers planted the grass plugs in October 1998 along the top of the slope and at the bottom near the boundary fence. In early spring, 1999 the same area of the hill was hydroseeded with bluebunch wheatgrass and sheep fescue. The spring and summer of 1999 were warm and dry, and most of the plugs did not survive the summer. Only a small percentage of the hydroseeded area grew grass that survived into the fall. The

south aspect of the hill, C2 (5) contains scattered snow buckwheat, lupine, and a few native grasses. Cheatgrass is the predominant plant. (Source: Trick, Roger. WHMI. 2002. Personal Communication)

3. 2000- Since 2000, park staff has spot sprayed yellow starthistle on all areas of Memorial Shaft Hill, and kept it under control. Since then, more lupine has been spreading in C2 (H5) and C1 (H6). Park staff may experiment with a new control agent for yellow starthistle. Some research indicates that vinegar, when sprayed on immature plants, will kill up to 90 percent of the yellow starthistle stand. Whitman Mission staff may use this as a spot spray technique and monitor its effectiveness. (Source: Trick, Roger, WHMI. 2002. Revegatation Updates)

Area H6 - *This is the east aspect of Shaft Hill. The following are documented actions:*

1. 1990 Letter from Larry Larson observes that the Hill (Units H1-H6) represents a harsh environment with numerous exotic weed species. Units H1 and H6 should be burned this fall to remove weed residue, and help prepare the seedbed. The units will be monitored in February to determine when and application of 1 pt/A of Roundup should be applied to control annual weeds. Unit H6 will be drilled in March with Secar and Whitmar bluebunch wheatgrass, and Nezpar Indian ricegrass. This will be followed with a broadcast seeding of Sherman big bluegrass, Covar sheep fescue, and sand dropseed. (The recommendations were implemented. Personal Communication: Roger Trick, 2002) (Source: Larry Larson. Letter to Terry Darbey dated August 13, 1990. Subject Whitman Mission Vegetation Maintenance)
2. 1990s-After broadcast spraying the top of the hill (H6 and C1) with a general herbicide, the park planted it with bluebunch wheatgrass and other native grasses in 1991. The grasses established themselves over a few years and by the mid-1990s, the top of Memorial Shaft Hill had a good stand of grass that required only spot spraying to control the yellow starthistle. (Source: Trick, Roger. 2002. Revegetation Updates)
3. 1998-On the recommendation of the county weed control officer, the park applied a different herbicide in 1998 to control yellow starthistle. The herbicide Transline is expensive, but it is effective. It was used first on Area C2 (H5). On the south aspect of the hill in September, 1998 a prescribed fire got out of control and burned almost

all of C2 (H5) and a small area of C1 (H6). The prescribed burn was to prepare the area for vegetation plugs to be planted later that fall. Park staff and volunteers planted the grass plugs in October 1998 along the top of the slope and at the bottom near the boundary fence. In early spring, 1999 the same area of the hill was hydroseeded with bluebunch wheatgrass and sheep fescue. The spring and summer of 1999 were warm and dry, and most of the plugs did not survive the summer. Only a small percentage of the hydroseeded area grew grass that survived into the fall. The south aspect of the hill, C2 (H5) contains scattered snow buckwheat, lupine, and a few native grasses. Cheatgrass is the predominant plant. (Source: Trick, Roger. WHMI. 2002. Revegetation updates)

4. 1990s-After broadcast spraying the top of the hill (H6and C1) with a general herbicide, the park planted it with bluebunch wheatgrass and other native grasses in 1991. The grasses established themselves over a few years and by the mid-1990s, the top of Memorial Shaft Hill had a good stand of grass that required only spot spraying to control the yellow starthistle. (Source: Trick, Roger. 2002. Revegetation Updates)
5. Since 2000, park staff has spot sprayed yellow starthistle on all areas of Memorial Shaft Hill, and kept it under control. Since then, more lupine has been spreading in C2 (H5) and C1 (H6). Park staff may experiment with a new control agent for yellow starthistle. Some research indicates that vinegar, when sprayed on immature plants, will kill up to 90 percent of the yellow starthistle stand. Whitman Mission staff may use this as a spot spray technique and monitor its effectiveness. (Source: Trick, Roger, WHMI. 2002. Revegetation Updates)

Area H4, H5, H6 – Whitman Mission National Historic Site 1990 – 2002

	1990 Late Winter	1990 Fall	1991 Late Winter	1991 Late Winter	1998	1999 Spring	2000	2001	2002
Area H4 (part of C3)									
Wildfire Burned									
Seeded - bluebunch wheatgrass									
Seeded - west end with great basin wildrye									
Mowed - yellow starthistle (1998-2002)					Sp/Summer 1998-2002				
Area H5									
Area Seeded									
Area Sprayed - Transline for star thistle									
Prescribed fire - out-of-control burned area									
Planted grass plugs									
Hydroseeded - bluebunch wheatgrass/sheep fescue									
Spot spraying - star thistle 2000-2002							Sp/Summer		
Area H6									
Area Burned									
Spray - with Roundup									
Area Seeded - Secar and Whitmar bluebunch wheatgrass and Nez Perce Indian Ricegrass									
Broadcast Seeded - Sherman big bluegrass, Covar sheep fescue, sand drop seed									
Prescribed fire - out-of-control									
Planted grass plugs									
Hydroseeded - bluebunch wheatgrass, sheep fescue									
Spot Sprayed - starthistle (2000-2002)							Sp/Summer		

Legend	
Area Treatments	
Grazed	
Round-up	
Burned	
Rototilled	
Seeded	
Herbicide	
Mowed	
Biocontrol	
Irrigated	

Area V - *This area includes the Visitor's Center in the central portion of the Park. The following are documented actions:*

1. In 1989, NHS staff established a native ryegrass demonstration plot by the visitor center (this was designated Area V in the Plan). Planted with mixture of Magnar Great Basin wildrye and Sherman big bluegrass. (Source: USDI. National Park Sevice, General Management Plan, September 2000)

2. 1989-90. The entrance road was redone in the summer of 1989 and the area adjacent to the pavement was seeded (1.2A) in November. The borrow pits on both sides of the road were hydro-seeded using two passes. The first pass deposited the seed with a light coating of colored wood fiber. The second pass covered the seed with a wood fiber mulch and tackifier (2000 lbs/A). Two sites exist within each borrow pit: 1) The area next to the asphalt which is a constructed roadbase with a "soil" varying in depth from ½ to 4 inches in depth over laying a rock/dirt base, and 2) the area extending from the roadbase to the fence line which was relatively undisturbed during road construction. Area 1 presents a sloping surface that will be dry due to surface water runoff, low in nutrients, and compacted. This area was roughened with a harrow prior to seeding. The seed mix consisted of Covar sheep fescue, Sherman big bluegrass, Critana thickspike wheatgrass, and Sodar streambank wheatgrass seeded at the rate of 30 lbs/A. Area 2 was sprayed with Roundup at the rate of 1 qt/A followed by tillage to prepare a seedbed. This area receives the benefit of surface water runon and will support basin wildrye. The seed mix consisted of Magnar basin wildrye, Secar bluebunch wheatgrass, Whitmar bluebunch wheatgrass and Sherman big bluegrass seeded at the rate of 30 lbs/A. These recommendations were carried out: Personal Communication, Roger Trick, 2002. (Source: Larry Larson. Whitman Mission Restoration Annual Report; 1989. Received WHMI Dec. 20, 1989.)

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Whitman Mission National Historic Site. Individual Fire Report. September 16, 1998.

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Appendix A

Chronological Order of Studies, Reports, and Recommendations relating to the Revegetation Program

The following listing is a compilation of excerpts of studies, reports and recommendations made regarding the Revegetation Program at Whitman Mission. The listing is by area and in chronological order.

Area A

1984 - A

This early study divides the park into six land units, including Area A:

This study divides Whitman Mission and surrounding areas into six land units. Area A is outside the Park Boundary and is not in control of the Park, but is of concern to the Park and its resources.

(Source: Gilbert, C.A., USDI National Park Service, 1984. Landscape Study and Management Alternatives for Revegetation, Whitman Mission National Historical Site. National Park Service Interdisciplinary Study by the Pacific Northwest Regional Division of Cultural Resources, Science and Technology, Resource Management.)

Area B

1984 - B

This early study divides the park into six land units, including Area B:

Area B includes the 27 acres south of the mission grounds. Alternatives for this land unit are [1] Restore Original Vegetation; Bluebunch wheatgrass (*Agropyron spiceyum*), Sandberg blue (*Poa secunda*), and riparian woodland with grant rye, [2] Seed to tall wheatgrass (*Agropyron elongatum*), fence into three pastures, and rotate grazing, [3] Seed to tall wheatgrass and use as a single pasture, [4] Utilize existing pasture, construct fences (multi-pastures), and develop rotational grazing, and [5] Continue current management program, but adjust stocking rates and season of use to reduce impact.

(Source: Gilbert, C.A.,USDI National Park Service, 1984. Landscape Study and Management Alternatives for Revegetation, Whitman Mission National Historical Site. National Park Service Interdisciplinary Study by the Pacific Northwest Regional Division of Cultural Resources, Science and Technology, Resource Management.)

The following overview is contained in a letter from Ed Starkey, Research Biologist, to James Larsen, Chief Scientist, both NPS, with various alternatives for this Area (In Starkey's letter it was referred to as Area A, but further review by Roger Trick 8/19/02 indicates that it is actually Area B):

Area B: This area has been leased for cattle grazing for many years. Furthermore, the river channel has been modified which no doubt changed the water table. The area has been seeded to forage species such as bluegrass and clover, and has been irrigated. Thus, because of this history of disturbance, restoration of historic plant communities would be very difficult, even impossible. Changes in the water table alone may preclude any such attempt.

However, a 'pastoral' setting can be maintained using several alternative management approaches. Selection of a particular alternative will depend upon management objectives for the area.

R.Pudney and R. Zarwell of the SCS evaluated the pasture in 1978, and developed the following management programs:

Alternative 1: Seed the area to tall wheatgrass (*Agropyron elongatum*), fence into three pastures, and rotate grazing.

Alternative 2. Seed to tall wheatgrass and leave as a single pasture.

Alternative 3: Construct fences and develop a rotational grazing system of the existing Kentucky bluegrass pasture.

Alternative 4. Continue current management program.

From an ecological perspective, any of these four alternatives are reasonable, even Alternative 4. Although the pasture showed signs of localized erosion, it appeared to be in generally good condition. Admittedly, we visited the park during the spring when growing conditions were ideal. Nevertheless, the pasture was not in bad shape. If this alternative was selected, stocking rates and season of use could be changed to reduce localized impacts.

Cross-fencing as included in Alternative 3 would definitely increase the productivity of the pasture, and would probably decrease erosion impacts. This would be a form of "high intensity-short duration" grazing system. Livestock are placed in small pastures at high stocking rates, and moved frequently. One advantage of this approach is the consumption by livestock of both preferred and non-preferred forage plants. This decreases the competitive advantage of unpalatable plants over highly preferred species. The system is especially successful for pastures with a significant legume component. These plants fix atmospheric nitrogen and are consumed by herbivores. Most of the nitrogen is then returned to the soil via feces and urine. Thus nitrogen is cycled from the legume to the soil, and is available to other plants as well as the legume.

Both Alternatives 3 and 4 would require continued irrigation, and the conspicuous presence of cattle or sheep during the grazing season. Irrigation may be distracting to park visitors; however, the lessee could be required to irrigate at night and in early mornings when visitors are not present. Sprinklers are commonly moved every 12 hours and, aside from inconvenience to the lessee, I see no reason why 27 acres couldn't be irrigated adequately using such a program.

Alternatives 1 and 2 would not require long-term irrigation, although it may be desirable to irrigate until tall wheatgrass is established satisfactorily. Neither of these alternatives would result in a return to vegetation typical of the Whitman period, but irrigation would be eliminated or reduced, and the stocking rates, and period of use by livestock would be greatly reduced.

The suggested alternatives range from high intensity (Alternative 3) to low intensity (Alternative 2) pasture management. The natural resource can be managed properly under any of the alternatives, but impacts on visitors experience and interpretation of the historic resource will differ.

Further work will be required to refine any Alternative selected. For example, tall wheatgrass seems like a reasonable choice for an unirrigated pasture but other species such as tall fescue may also be suitable. Additional consultation with the SCS, and county and university extension personnel would be desirable.

(Source: Starkey, E. Letter and report dated May 31, 1984 to James Larsen, Chief Scientist, NPS, Pacific Northwest Region, Seattle, WA.)

1986 - B

The following report from Jim Romo to Robert Amdor summarizes treatments for Area B in 1986:

Unit B: Unit B was grazed during early spring 1986 and Roundup was applied to kill perennial grasses in preparation for seeding. The Roundup application appears to have killed grasses, but as previously recommended, Roundup should be applied again in Spring 1987. It may not be necessary to spray the entire area. In 1987; localized areas that green-up in Spring 1987 should be treated.

Unit B should be disked in late fall 1987 and planted to Magnar Basin Wildrye (*Elymus cinereus*) using procedures previously recommended. Mowing at a height of 4 to 6 inches may be necessary to limit growth of weedy species the first two growing seasons after seeding. This area must not be grazed or burned for at least 3 years following seeding.

(Source: Romo, J. Letter and report to Robert Amdor, WHMI, dated July 7, 1986. Report is A Survey of the Revegetation Efforts at Whitman Mission National Historic Site and Recommendations for Continued Success)

1987 - B

The following memo from Larry Larson to Roger Trick from 1987 lists observations and recommendations for Area B:

Area B, prior to treatment, was dominated by Kentucky bluegrass, quackgrass and clover. The area was treated with Roundup during the spring of 1986 to control these species. Observations made on April 8 suggest that between 90 to 100 percent of the target species were removed from the site. The following steps need to be taken this spring to prepare the area for a successful planting this fall:

[1] Prior to April 24, 1987, the area should receive a second treatment to roundup to control the production of annual weed seeds. This treatment was previously scheduled for May or June of 1987; however, the early spring weather has required our recommendation to be pushed forward in time to achieve maximum benefit from the treatment.

Treatment:

Compound: Roundup

Rate:1 quart of Roundup mixed in 40 gallons of water should be applied to each acre. The mixture should be sprayed with a nozzle pressure of 40 psi.

Time: The herbicide mixture should be applied in the early morning prior to 9:00 AM to minimize drift. The air should be calm with no indication of impending rain.

[2] Two-three weeks after Area B has been treated with Roundup the area should be disked to begin preparation for a fall seeding. A spot spraying with Roundup may be necessary in the fall to treat small patches of weed prior to seeding.

(Source: Larson, L. Memo dated April 9, 1987, Rangeland Resource Department, Oregon State University and O.S.U Agriculture Program, Eastern Oregon State College to Roger Trick, Acting Superintendent, Whitman Mission. Subject: Whitman Mission Revegetation Project).

An Individual Fire Report dated May 29, 1987 documents a prescribed burn of 29 acres in Area B.

(Source: WHMI. Individual Fire Report, May 29, 1987)

The following letter from Larry Larson to Superintendent Herrera summarizes visits to the

Mission on June 10 and 16, 1987:

Revegetation Objective: The objectives of the revegetation project were discussed on June 16 to determine if minor adjustments in the progress were necessary at this point in time. A review of the species that are native to the mission, seed sources availability, and seeding characteristics were compared to the species that currently dominate the mission. The review identified a two-phase objective for the revegetation project. The first phase of the revegetation will be directed toward the establishment of species on the mission that are ecologically equivalents to the native vegetation of the mission. This direction was selected for several reasons: [1] Widening the species selection process to include ecological equivalents permits the selection of species that will provide a similar appearance to the native species that originally dominated the mission, [2] The selection of ecological equivalents provides a wider range of species to select from so that species can be selected based upon their competitive abilities to replace the introduced annual species that currently dominate much of the mission, and [3] The selection of ecological equivalents provides a wider range of seed sources and permits you to select varieties that are more suited to the climatic conditions of the Whitman Mission than the

southern varieties (less suited to northerly climates) that are currently available for several of the native species. The second phase of the project will involve the replacement of the ecological equivalents with native species. This will occur over a number of years in a manner that will optimize the establishment of native species and minimize the opportunity for annual weed invasion. Structuring the revegetation program in this way will ensure quicker results in the program so that the vegetation of the Mission can be returned to an appearance similar to the native vegetation at relatively early date. Then the more difficult task of establishing native species on the mission can occur over a longer time period to minimize the chance of annual weed invasion.

Area B was treated with Roundup according to the prescription recommended in the April 9 report. The area was burned at a later date to remove the dead material from the site. The treatment of the site was effective over 85 to 90 percent of the area. The 10 to 15 percent of the area that did not respond to the treatment are either skip spots in the treatment application or areas where the vegetation was too thick for adequate herbicide penetration. These areas should receive a follow up spot treatment to control the weedy species.

Treatment compound: Roundup

Rate: 1 quart of Roundup mixed in 40 gallons of water (containing a sticker compound) should be applied per acre on those areas requiring a follow up treatment. The timing of the treatment was discussed at the June 16 meeting and was scheduled to occur before the end of June while adequate soil moisture was present.

(Note: From Roger Trick 8/19/02-Half of Area B seeded in Fall 1987 with same seed mixture as on March 11, 1988 on rest of Area B)

(Source: Larson, L. Oregon State University. Letter to Dave Herrerra WHMI, Dated June 22, 1987)

1988 - B

This report from Larry Larson to Ed Starkey Dated April 18, 1988 summarizes trips made to Whitman Mission between February 25 and April 13, with observations and recommendations related to Area B:

February 25:

[1] Grass seedlings approximately 1-2 inches in height were observed on all of the areas that had been seeded in the fall. Weed competition was at a minimum and areas with colder soils (litter and/or more soil water) had fewer grass seedlings at that time.

[2] The portion of area B that was roto-tilled last fall had numerous weed seedlings and was too wet to be seeded.

March 8

[1] Area B had dried sufficiently to recommend the following activities: [a] Spray tilled area with Roundup at a rate of 1 pint per acre, and [b] Schedule a day for drilling the grass seed.

[2] Recommend that Areas E & F be burned or mowed and that Area F be fertilized at a rate of 25-30 lbs. of nitrogen per acre to improve the vigor of the existing grass stand.

March 11

[1] The tilled portion of Area B was seeded with a mixture of tall wheatgrass, basin wildrye, basin wildrye, and pubescent wheatgrass. The swale areas were too wet to be drilled so

they were broadcast seeded with reed canarygrass, sheep fescue, Sherman big bluegrass, tall wheatgrass, and basin wildrye. The area needed rain for the drilled areas to germinate.

Area B

Upland area was seeded primarily to tall wheatgrass and basin wildrye:

Seeded grass=10.8-15.1/,1m sq. (.95CI)

Weeds=2.6-5.6/.1m. sq.

Henbit was the predominant weed and was not a problem at that time. I did not try to separate wheatgrass from wildrye.

The narrow drainage ways were not sampled-germination was poor and should improve with warmer weather.

April 13

[1] The portion of Area B that was seeded on March 11 has germinated and seedlings are 1-2 inches in height. The problem in this area is that the rain that was necessary to germinate grass also germinated weed seeds that were in the soil. This area will need to be monitored closely to ensure that the weeds do not overtake the grass seedlings.

Fall Seedings

Area B

Grass seedlings are vigorous and are at the 4-5 leaf stage. The henbit has the potential of becoming a problem on the site because it is overtopping the grass in some areas. Henbit is resistant to 2,4-D so mowing is the most effective treatment that we have available to us. The area will be mowed on April 18 and should control the henbit.

Conclusions:

[1] The grass stands that were planted last fall appear to be healthy and should be established by fall. The area that will be the slowest to become established will be Area D2.

[2] The portion of Area B that was seeded this spring is doing OK but is going to be much more dependent upon the rains that occur this growing season than the fall seedings.

[3] Weeds are going to be present in every grass seeding this year. The number of seeds that are present in the soil seed bank is quite large and we should anticipate different weed species to emerge in the grass stands after each rain this summer. Weeds such as henbit will require mowing because they are resistant to the herbicides that we have available to us. We will be able to control some of the other weeds with 2,4-D after the grass develops more.

[4] I believe that the Park Service should reconsider the possibility of using a single application of Tordon (1/4 lb/acre) as part of the seedbed preparation prior to seeding weedy areas to grass. The single application would eliminate most of the broadleaf weed seed germination problems facing Whitman Mission. We can reach our goals without the use of Tordon but it will take us longer, sacrifice grass vigor, and cost more.

(Source: Larson, L. Letter and Report to Ed Starkey Dated April 18, 1988. Subject Whitman Mission Revegetation work.)

The text of this report from Larry Larsen in 1988 describes proposed spray and seeding activities for the summer of 1988 related to Area B:

Includes 10 acres with fall of 1987 seeding in area B (No map included), with spray treatments of Banvel, 2,4-D and 18 acres of spring (March, 1988) seeding with treatments of Glean, Banvel, and 2,4-D.

Conclusions: Dr. Larsen voiced concern about length of time to get approval from Washington for chemical applications, and the narrow windows of time available for effective spraying. If spraying is delayed to a major degree, other treatments are estimated to cost more and be less satisfactory.

(Source: Larson, L. Project description to Dave Herrerra dated April 28, 1988 on the Whitman Mission spray program)

Excerpts from Annual Report, 1988:

The purpose of this report is to provide a written record of the revegetation project at Whitman Mission during the time period April 1987 through December 1988. Prior to 1987, the Park Service contracted with Oregon State University to develop a revegetation plan. However, several revegetation failures resulted when the plan was implemented without adjusting the plan to current site conditions. As a result the current contract was adjusted so that on-site consultation would occur during the implementation of revegetation projects.

This report contains detailed observations and recommendations for areas of the park, as well as photo documentation of the ongoing treatments:

*Area B: Area B contains 28 acres. The historic record indicates that the area was originally occupied by a stand of basin wildrye (*Elymus cinereus*) and that the Walla Walla River meandered through this unit. Since that time period the area was converted to tame pasture (non-native) for livestock production and the Walla Walla River migrated outside the park boundary. In April 1987 area B was dominated by annual and biennial weeds. The weed population was the direct result of an application of Roundup the previous year to remove the non-native pasture species. The herbicide application eliminated the pasture grasses, while creating a 28 acre weed patch.*

<u>April-June</u> Photo 1

Area B was sprayed with Roundup (1 qt/acre) in late April 1987 to begin the process of seedbed preparation for a fall seeding. The weed population at that time was approximately 2 feet tall. Photo 1 indicates that the spray program did an effective job of controlling the weed population. The area was burned in late May to remove the residue.

<u>June-September</u> Photo 2

Weeds began to reinfest ½ of unit B in June. The most troublesome weed species were common mallow (*Malva neglecta*) and pigweed (*Amaranthus retroflexus*). The infested area was spot treated with Roundup (1 qt/acre) in late June with limited success (common mallow is resistant to the herbicide cleared for use on the park). Consequently it was determined that it would be better to till the area in the fall rather than attempt to control the mallow with repeated herbicide applications. Photo 2 provides an example of the common mallow infestation in September. The infested area was tilled in late September, killing the common mallow, and preparing a seedbed for spring planting.

<u>October-February</u> Photos 3-5

The untilled portion of area B was seeded with a John Deere Power Seeder (Photo 3) in late October 1987. The seed mix was comprised of 40% "Alkar" tall wheatgrass (*Agropyron elongatum*), 40% "Magnar" basin wildrye (*Elymus cinerus*), 10% "Luna" pubescent wheatgrass (*Agropyron trichophorum*), and 10% "Secar" bluebunch wheatgrass (*Agropyron spicatum*). The

area was seeded at a rate of 30-40 pure live seeds per square foot. Photos 4 and 5 show the seeded area in late February. A slight tinge of green can be seen in the drill rows where the grasses are beginning to emerge. The green area in photo 5 is an area of bulbous bluegrass (*Poa bulbosa*) that emerged on a gravel bench.

Mid-March to April 1988 Photos 6-8

In mid-March the tilled portion of area B was dried sufficiently to permit the area to be seeded. The John Deere Power Seeder and the same seed mix were used on this portion of the area. The old river channel was broadcast seeded at the same time with a mixture of "Sherman" big bluegrass (*Poa ampla*) and "Vantage" reed canarygrass (*Phalaris arundinacea*). Photo 6 shows the condition of the seedbed prior to seeding. The dark area (wet soil) is a section of the old river channel that was broadcast seeded. Photos 7 and 8, of the fall seeding, were taken in March in the same general area as photos 4 and 5. Both photos shoe an increase in grass and weed emergence. The density of the grass and weed seedlings in March were:

Density (plants/ .1 meter sq.)
Seeded grass 10.8-15.1
Weed species 2.6-5.6

Mid April-May

In mid-April the fall seeding contained patches of henbit (*Lamium amplexicaule*) that were beginning to compete with an otherwise vigorous stand of grass (Photo 9). The spring seeding began to emerge in mid-April (Photos 10-11). In early May, the fall seeding was mowed to a 6-inch height in an attempt to stunt the henbit and release the grass. Unfortunately the area received a rain after the mowing treatment and the henbit continued to grow at a rapid rate.

In mid-May it became obvious that both the fall and spring seedings would require herbicide treatment if the grass stands were going to survive. Photo 12 provides an example of the henbit/common mallow growth that was occurring in the spring seeding. The weed patches were totally shading the grass seedlings. Photos 13 and 14 provide an indication of the degree of henbit competition that was occurring in the fall seeded area. The fall seeding was treated with Banvel (.25 lb ae/A) and 2,4-D (.5 lb ae/A) mix. The spring seeding was treated with Glean (.13 oz ai/A) in May and the Banvel and 2,4-D mix in June. Neither herbicide treatment was designed to provide 100 percent control of the weed population, rather the treatments were designed to stress the weed population and release the grass stand from excessive competition.

<u>June</u> Photos 15-22

The fall seeding dominated Area B in June. Photos 15-17 were taken at three locations in the fall seeding. Photos 18-20 were taken in the area that received the spring seeding treatment. The reader should note the difference in grass height between fall and spring seeding and that although weeds were present in the understory of both seedings they were not threatening the success of either grass stand. Photos 21 and 22 were taken in a one acre area that was seeded in the spring but could not be treated with herbicide because the equipment could not cross a portion of the old river channel. As a result the grass population in this area was severely stressed by weeds and may need to be planted again.

<u>July-August</u> Photo 23

Photo 23 illustrates the height of the grass stand in August. The fall and spring seedings had similar height growth at this time. Density measurements taken during this time period indicate:

Density (plants/.1 m sq)
Fall seeding 6-8 (grass)
Spring seeding 5-7 (grass)
Weed dominated site 2-4 (weeds)

(Source: Larson, L. Rangeland Resources Department, Oregon State University, 1988. Annual Report: Whitman Mission Revegetation Project.)

1989 - B

This Annual Report contains the following detailed summary of actions taken in the park for the revegetation project:

AREA B. Specific management prescriptions were not required for most of Area B (Figure 1) in 1989. The grass stands that were planted in 1987 became established over most of Area B during the 1989 growing season. The only herbicide treatment prescribed for this area was a spot spray (2,4-D/Banvel mix) program conducted on 2 acres of the 28-acre unit to control Canada thistle.

The seeded plant community has stabilized this site and is controlling weed encroachment. The dominant grass of the flood plain, tall wheatgrass, was over 6 ft in height in 1989. The former river channels are revegetated with the seeded species of reed canarygrass and Sherman big bluegrass with areas of rush, smartweed and cattail. The latter three species (native) were not seeded but moved in with seasonal flooding. In addition, wildlife (deer, badger, rodents, upland game birds, songbirds, etc.) usage in area B and D2 has increased dramatically over the past two years.

Area B will receive maintenance management for the next several years so that successional processes can be allowed to modify the seeded plant community, reduce the remaining weed seeds located in the soil, improve soil organic matter, and soil moisture characteristics. Then, as time and budgets permit, islands of vegetation will be removed and additional native grasses, forbs and shrubs established (refer to procedure being used on the Fescue Field.)

The only revegetation activity scheduled for area B this fall was a broadcast seeding of Sherman big bluegrass and Covar sheep fescue. This seeding occurred on a ½ acre area of the flood plain where the soil is too shallow (gravel bar) to support a dense stand of tall wheatgrass.

(Source: Larson, L. Whitman Mission Revegetation Annual Report, Rangeland Resources Department, Oregon State University; 1989. Received WHMI Dec. 20, 1989)

This text is included in the hard backed photo album labeled "Revegetation Project which includes the following progress reports specific to Area B from 1987-1989. 1987:

Area B contains 28 acres. The historic record indicates that the area was originally occupied by a stand of basin wildrye and that the Walla Walla River meandered through this unit. Since that time period the area was converted to tame pasture (non-natives) for livestock production and the Walla Walla River migrated outside the park boundary. In April 1987 area B was dominated by annual and biennial weeds. The weed population was the direct result of an

application of roundup the previous year to remove the non-native pasture species. The herbicide application eliminated the pasture grasses, while creating a 28-acre weed patch.

Area B-1988:10 acres were seeded with a John Deer Power Seeder in late October, 1987. The seed mix was 40 percent Alkar tall wheatgrass, 40 percent Magnar basin wildrye, 10 percent Luna pubescent wheatgrass, and 10 percent Secar bluebunch wheatgrass. The remaining 18 acres were seeded in mid-March, 1988 with the same mixture. Because of serious weed competition, the area was sprayed in mid-May, 1988 and again in June with a mixture of Banvel and 2,4-D and with Glean.

Area B-1989:

We have had vigorous growth of these grasses this year. We have used no herbicides in Area B except to spot spray Banvel for thistles in a two acre area. Most of the grass is 4-7 feet tall.

Plans:

Fall 1989. We plan to use Roundup to open some patches in the grass so we can plant forbs. We have the following seed we could mix, although some are more suited to drier areas, and others to moist microenvironments. The species are: western yarrow, Louisiana sage, blanket flower, Rocky Mountain iris, black-eyed susan, globemallow, goldenrod, and mountain thermopsis.

(Source: Text of 1988 Annual Report by Larry Larson is included in a hard-backed photo album labeled "Revegetation Project, and includes a page of introduction that apparently is from 1989, as well as recommendations for 1990. This album contains numerous photos of the revegetation program and is part of the monitoring record)

1994 - B

An Individual Fire Report dated March 15, 1994 documents a prescribed burn of 29 acres in Area B.

(Source:WHMI. Individual Fire Report, March 15, 1994)

1996 - B

An Individual Fire Report dated March 19, 1996 documents a prescribed burn of 25 acres in Area B.

(Source: WHMI. Individual Fire Report, March 19, 1996)

1998 - B

An Individual Fire Report dated March 5, 1998 documents a prescribed burn of 28 acres in Area B.

(Source: WHMI. Individual Fire Report, March 5, 1998)

Area C

1984 - C

Area C includes approximately 8 acres and the hill known as Shaft Hill. This is part of the geological terrace rising approximately 100 feet above the mission. Alternatives for this land unit are [1] Re-establish original native vegetation; bluebunch wheatgrass and Idaho fescue with a mixture of scattered rabbitbrush and big sage, [2] Reinforce establishment of native species; bluebunch wheatgrass, [3] Maintain present "shady lane" character of trail between units C and F with stature trees by transplant of similar species as current trees become hazardous, and [4] replace irrigation ditch species with shrub-like native/non-native species that act as bank stabilizers.

(Source: Gilbert, C.A., USDI National Park Service, 1984. Landscape Study and Management Alternatives for Revegetation, Whitman Mission National Historical Site. National Park Service Interdisciplinary Study by the Pacific Northwest Regional Division of Cultural Resources, Science and Technology, Resource Management.)

The following overview of this Area (Initially identified as Area B in Starkey's letter, but later confirmed to be Area C by Roger Trick 8/19/02) from 1984 is contained in a letter from Ed Starkey, Research Biologist to James Larsen, Chief Scientist, both NPS, with various recommendations for treatment:

This area includes Shaft Hill and historic vegetation probably consisted of bluebunch wheatgrass and Idaho fescue, with scattered rabbitbrush and big sagebrush plants, and various forbs. Currently, cheatgrass (*Bromus tectorum*) is very abundant, and rabbitbrush density has increased.

Elimination of the exotic cheatgrass would be highly desirable from a park management perspective, but it is probably not possible. However, recent research at John Day Fossil Beds National Monument suggests that density of native grasses can be increased and that these grasses can be reestablished in areas where they have been eliminated by exotic competition.

Most of this work has been done with bluebunch wheatgrass, so initially at least, vegetation management of Shaft Hill should focus on this species. Further research should provide additional information on reestablishment of Idaho fescue and various forbs.

I suggest that we attempt to establish good stands of bluebunch wheatgrass along the trail. Our initial efforts should probably be concentrated on the south-facing aspects of the hill. Bluebunch wheatgrass typically is dominant on drier sites, with Idaho fescue more abundant on moister and cooler sites, such as those with northerly aspects.

Although seeds could be harvested locally from bluebunch wheatgrass plants, this process is time consuming. The Soil Conservation Service has recently released a new variety: Secar bluebunch wheatgrass which has been tested at John Day Fossil Beds NM. Seedlings were grown in "tubepaks" and then were planted directly into cheatgrass stand. The "tublings" showed very good survival, and Secar actually had higher survival rates than local varieties. Secar was developed in Pullman, Washington, and should be suitable for the Walla Walla area.

If tublings are planted with spacings of about .3 meters, annual grasses should be suppressed and a bluebunch wheatgrass stand established fairly quickly. Planting should occur during the fall so that seedlings can take advantage of winter and early spring moisture. Although I am confident that this approach would be successful, it would be useful to have Drs. Marchall Haferkamp and Rick Miller of the Eastern Oregon Agricultural Experiment Station visit the park, and provide specific recommendations.

Obviously, the establishment of bluebunch wheatgrass stands in selected areas of Shaft Hill does not constitute a return to native vegetation. However, it is a first step. Enhancement of other native species, and reduction of the density of exotics and "increaser" native species will require a long term program which may include prescribed fire**.**

(Source: Starkey, E. Letter and report to James Larsen, Chief Scientist NPS Pacific Northwest Region, dated May 31, 1984.)

The following overview of Area C from 1984 is contained in a letter from Ed Starkey, Research Biologist to James Larsen, Chief Scientist, both NPS, with various recommendations for treatment:

Area C: This area has been farmed and otherwise heavily disturbed for many years. Canary grass dominates the wetter sites, and exotic and noxious annual plants dominate the upland areas. Yellow starthistle is abundant.

Because of the presence of these highly competitive plants, reestablishment of native vegetation would be difficult, or impossible. However, a stable non-native grassland community can be established if suitable site preparation occurs. Mr. Larry Hooker of the Soil Conservation Service suggested in a memo dated 9/10/81 several alternative approaches. I believe that his Alternative 1 has the best chance of succeeding. This involves disking in the fall, followed by herbicide treatment of re-growth. Fields would be disked, harrowed, packed and seeded the next spring. It may even be necessary to summer fallow the field and plant in the second fall. Seeding in the fall allows germination with any fall moisture, and an early start the next spring. There would be a certain amount of soil loss to wind erosion, but this potential would have to be balanced against the increased probability of successful seeding.

The procedure could be modified to utilize the land imprinter which will be tested at John Day Fossil Beds NM during the fall of 1984. The imprinter consists of a large heavy roller with patterned lugs covering the surface. Seed is broadcast in front of the imprinter and imbedded in the soil. This procedure results in randomly distributed individual plants, rather than the precise rows produced by rangeland drills.

Although there are a number of species which could be planted in this area, I recommend that we use a species which has demonstrated ability to compete with noxious invaders. This requirement will most likely be met by non-native species such as pubescent wheatgrass, although streambank or thickspike wheatgrasses may be possibilities. Furthermore, a determined and aggressive approach to site preparation will be required. As demonstrated by the generally unsuccessful previous attempt to establish streambank wheatgrass, half measures will be a waste of time and money. Competition must be reduced before seeding to allow the desirable species

to become established. It seems likely that herbicides, plowing and disking, and fire will all be required.

Following the establishment of a stable grassland, reestablishment of native species can be attempted on selected sites, if this seems desirable. For now, the elimination of noxious weeds is the most important objective. As for Areas A and B, the action plan should be developed in consultation with SCS, county extension, and university personnel.

(Source: Starkey, E. Letter and report to James Larsen, Chief Scientist NPS Pacific Northwest Region, dated May 31, 1984.)

1989 - C

This text is from the hard-backed folder labeled "Revegetation Project", and includes a discussion of Area C from 1987 to 1990:

This is the Whitman Memorial Shaft Hill, 100 feet high, with north, west and south aspects within the park. On the southern aspect in the fall, 1988, a neighboring farmer was burning weeds near our boundary and lost control of his fire. Approximately 5 acres of the southern aspect and the top of the hill burned. We planted a variety of grass seed on top, half-way down the slope, and at the bottom of the hill immediately after the fire. The only species to grow in 1989 was Sherman big bluegrass.

Fall 1989

We will probably use a hydroseeder to plant Sherman big bluegrass on the southern aspect of the hill. (Note from Roger Trick 8/19/02: This was done, but did not get good germination. Determined it was a failure by 1991.)

1990 - C

During 1990 we may plan how to revegetate the rest of the hill. This may take the use of Picloram on this part of the hill.

(Source: Text of 1988 Annual Report by Larry Larson is included in a hard-backed photo album labeled "Revegetation Project, and includes a page of introduction that apparently is from 1989, as well as recommendations for 1990. This album contains numerous photos of the revegetation program and could be part of the monitoring record)

1997 - C

An Individual Fire Report dated July 1, 1997 documents a prescribed burn of 1.3 acres in Area C.

(Source: WHMI. Individual Fire Report, July 1, 1997)

Area C1

1986 – C1

The following description and recommendation of Area C1 is from Jim Romo to the Superintendent in 1986:

Unit C1: Rye (*Secale cereale*) is locally abundant along the east side of Unit C1. This species is a concern to nearby landowners for fear of escaping into their fields. This species can be controlled by applications of Roundup. It was recommended either this treatment be applied just prior to the boot stage, or seedheads be cut off the plants before the seeds begin to shatter.

(Source: Romo, J. Letter and report to Robert Amdor, WHMI, dated July 7, 1986. Report is A Survey of the Revegetation Efforts at Whitman Mission National Historic Site and Recommendations for Continued Success).

Area C2

1998 – C2

An Individual Fire Report dated September 16, 1998 documents a prescribed burn of 3 acres in Area C2.

(Source: WHMI. Individual Fire Report, September 16, 1998)

Area D

1984 - D

This early study divides the park into six land units, including Area D, and contains the following alternatives:

Area D includes approximately 40 acres in the northern most portion of the Park. Alternatives for this land unit are [1] Re-establish native vegetation; the text says that this is not feasible because of previous man-caused disturbances, and is an admixture of noxious weeds and nondesirable grasses with high gopher population, [2] Retain present situation, while controlling weeds with chemical treatments, [3] Establish a stable non-native grassland community, using mechanical and chemical treatments, summer fallowing and seeding with native/non-native desirable species.

(Source: Gilbert, C.A., USDI National Park Service, 1984. Landscape Study and Management Alternatives for Revegetation, Whitman Mission National Historical Site. National Park Service Interdisciplinary Study by the Pacific Northwest Regional Division of Cultural Resources, Science and Technology, Resource Management.)

Area [D] This area is an overlay design exercise of fairly low priority. CR will develop possible options for visitor use for WHMI consideration as part of the final report.

(Source: Amdor, R. Draft Task Directive: WHMI Landscape/Revegetation Schematics. 1984)

Area D1A

1986 – D1A

This report from Jim Romo to the Superintendent contains recommendations for Area D1A in 1986:

Unit D1A: This unit should be burned in early spring 1987. Grazing can continue in D1A but it must be fenced off from surrounding units to prevent damage to areas being revegetated.

(Source: Romo, J. Letter and report to Robert Amdor, WHMI, dated July 7, 1986. Report is A Survey of the Revegetation Efforts at Whitman Mission National Historic Site and Recommendations for Continued Success.)

1987 – D1A

This memo from Larry Larson to Roger Trick in 1987 contains the following observations and recommendations for Areas D 1a & b:

The previous treatment of hemlock and teasel in these areas has greatly reduced the presence of these weeds. The remaining clumps of hemlock should be spot treated this spring to complete the objective on initial hemlock control. The spot treatment of the hemlock should occur before May 8, 1987.

Compound: Banvel

Rate: Mix at a rate of ½ lb to 5 gallons of water containing a wetting agent. The mixture should be applied with a backpack sprayer.

Timing: Individual plants should be thoroughly wetted. The spot spraying should be done under the same conditions as described for area B.

If spraying with the above herbicide is not possible then the remaining hemlock needs to be grubbed out with a shovel or at least mowed off to prevent seed production. If this approach is taken I recommend that one half of the hemlock be grubbed this year with the remainder mowed and then complete the grubbing program next year.

(Larson, L., Rangeland Resources Department, Oregon State University and O.S.U Agriculture Program, Eastern Oregon State College. Letter dated April 9, 1987 to Roger Trick, Acting Superintendent, Whitman Mission. Subject: Whitman Mission Revegetation Project)

The following memo from Larry Larson to Superintendent Herrera summarizes visits on June 10 and 16, 1987, with the following recommendations:

Area D1 a & b: The treatment described in the April 9 report was completed and the objective of controlling the poison hemlock has been achieved. The reed grass that dominates the site is in vigorous condition and does not require any additional treatment at this time.

(Larson, L., Assistant Professor of Rangeland Resources Dept., Oregon State University. Letter dated June 22, 1987 to Dave Herrera, Superintendent Whitman Mission. Subject: Whitman Mission Revegetation Project)

1995 – D1A

An Individual Fire Report dated March 27, 1995 documents a prescribed burn of 16 acres in Area D1a, D1b, D2, and E.

(Source: WHMI: Individual Fire Report, March 27, 1995)

Area D1B

1986 – D1B

This report from Jim Romo to the Superintendent contains recommendations for Area D1B in 1986:

Part of D1B is scheduled for seeding in Fall 1986. Cheatgrass (*Bromus tectorum*) was burned in this unit on 24 June, 1986. It was recommended that this area be mowed as soon as possible to prevent poison hemlock (*Conium maculatum*) from setting seed. Fall disking and spring seeding were recommended, as well as mowing at a height of 4 to 6 inches before cheatgrass develops seedheads. Unit D1B was not to be burned or grazed for at least 3 years.

(Source: Romo, J., University of Saskatchewan. Letter and report to Robert Amdor, WHMI, dated July 7, 1986. Report is A Survey of the Revegetation Efforts at Whitman Mission National Historic Site and Recommendations for Continued Success).

1987 – D1B

The following memo in 1987 from Larry Larson to Roger Trick contains observations and recommendations for Areas D1 a & b:

The previous treatment of hemlock and teasel in these areas has greatly reduced the presence of these weeds. The remaining clumps of hemlock should be spot treated this spring to complete the objective on initial hemlock control. The spot treatment of the hemlock should occur before May 8, 1987.

Compound: Banvel

Rate: Mix at a rate of ½ lb to 5 gallons of water containing a wetting agent. The mixture should be applied with a backpack sprayer.

Timing: Individual plants should be thoroughly wetted. The spot spraying should be done under the same conditions as described for area B.

If spraying with the above herbicide is not possible then the remaining hemlock needs to be grubbed out with a shovel or at least mowed off to prevent seed production. If this approach is taken I recommend that one half of the hemlock be grubbed this year with the remainder mowed and then complete the grubbing program next year.

(Source: Larson, L., Rangeland Resources Department, Oregon State University and O.S.U Agriculture Program, Eastern Oregon State College. Letter and report dated April 9, 1987 to Roger Trick, Acting Superintendent, Whitman Mission. Subject: Whitman Mission Revegetation Project)

The following memo from Larry Larson to Superintendent Herrera summarizes visits on June 10 and 16, 1987, with the following recommendations:

Area D1 a & b: The treatment described in the April 9 report was completed and the objective of controlling the poison hemlock has been achieved. The reed grass that dominates the site is in vigorous condition and does not require any additional treatment at this time.

(Source: Larson, L., Assistant Professor of Rangeland Resources Dept., Oregon State University memo dated June 22, 1987 to Dave Herrera, Superintendent Whitman Mission. Subject: Whitman Mission Revegetation Project)

1988 – D1B

An Individual Fire Report dated May 10, 1988 documents a prescribed burn of .1 acres in Area D1b.

(Source: WHMI. Individual Fire Report, May 10, 1988)

1995 – D1B

An Individual Fire Report dated March 27, 1995 documents a prescribed burn of 16 acres in Area D1a, D1b, D2, and E.

(Source: WHMI. Individual Fire Report, March 27, 1995)

Area D2

1986 – D2

This report from Jim Romo to the Superintendent contains recommendations for Area D2 in 1986:

Unit D2 had an application of Tordon in the spring of 1985 to eliminate yellow starthistle and diffuse knapweed. The unit was burned on June 24, 1986 to eliminate cheatgrass and pepperweed (*Lepidium perfoliatum*). The unit is to be disked in the fall of 1986, and timed to kill germinating cheatgrass. Magnar Basin wildrye and Secar bluebunch wheatgrass (*Agropyron spicatum*) must be seeded immediately after disking. It is anticipated that weeds will be abundant during the first and second growing seasons, therefore the unit should be mowed at a height of 4 to 6 inches when cheatgrass is headed out, to limit seed production. Grazing must not be allowed in this unit for at least 3 years after seeding.

(Source: Romo, J., University of Saskatchewan. Letter and report to Robert Amdor, WHMI, dated July 7, 1986. Report is A Survey of the Revegetation Efforts at Whitman Mission National Historic Site and Recommendations for Continued Success).

1987 – D2

The following memo in 1987 from Larry Larson to Roger Trick contains observations, and recommendations for Area D2:

Area D2 was treated in the past to control knapweed, starthistle, and cheatgrass. The area was seeded in the fall of 1986 and has a satisfactory stand of basin wildrye becoming established on the site. There are patches of cheatgrass that currently exist in the area due to the fact that most of the cheatgrass germinated in the spring of this year rather than last fall.

However, these patches are manageable if treated properly. I recommend that the cheatgrass patches in this area be mowed to a height of 4-6 inches as soon as seed heads begin to appear on the cheatgrass. These areas will be evaluated in mid to late summer to determine if a spot treatment of these areas will be required this fall.

(Source: Larson, L., Rangeland Resources Department, Oregon State University and O.S.U Agriculture Program, Eastern Oregon State College. Memo dated April 9, 1987 to Roger Trick, Acting Superintendent, Whitman Mission. Subject: Whitman Mission Revegetation Project.)

The following memo from Larry Larson to Superintendent Herrera summarizes visits on June 10 and 16, 1987, with the following recommendations:

Areas D2 and D3 are problem areas due to cheatgrass infestations on the sites. The native grass seedlings that emerged following the seeding last fall are being severely stressed by cheatgrass competition for moisture. Since a chemical compound does not exist that is selective toward cheatgrass at this stage of grass stand development, I recommend that both areas be burned when the cheatgrass enters the red color phase (anticipated to occur prior to July 10, 1987).

A portion of D2 and D3 will be selected for fall seeding. To prepare these areas for a successful seeding they will be sprinkler irrigated in the fall with 2 applications of ½ to ¾ inches of water in early September. This treatment will ensure that adequate fall moisture is available to germinate the cheatgrass seed in the soil. In mid to late October 1987 these areas will be sprayed with Roundup to control the cheatgrass. Both areas will be drilled with a rangeland drill in later October to early November. The rangeland drill has been selected for the seeding operation for two reasons: [1] The areas will not need to be disked prior to seeding. Disking has a tendency to bring buried weed seed to the surface where it readily germinates. [2] The rangeland drill causes minimal surface disturbance and does a better job of placing the seed in the soil than a Brillion seeder, thus maximizing the opportunity for seed germination and establishment.

(Source: Larson, L., Assistant Professor of Rangeland Resources Dept., Oregon State University. Letter dated June 22, 1987 to Dave Herrera, Superintendent Whitman Mission. Subject: Whitman Mission Revegetation Project)

1988 – D2

This report from Larry Larson to Ed Starkey Dated April 18, 1988 summarizes trips made to Whitman Mission between February 25 and April 13, with observations and recommendations related to Area D2:

Area D2:

The soft area is quite salty and has a tendency to crust over. The seedlings are the shortest in this area-possibly due to the whitish surface, the higher moisture content (irrigated the most in the fall) and/or the salt content of the soil. The area was seeded in the same way as D3.

Seeded grass

Wheatgrass/wildrye=7.4-11.4/.1m. sq.

Fescue/bluegrass=2.6-6.6/.1m. sq. (some of the bluegrass is bulbous bluegrass)

Weeds

Cheatgrass=.3-1.5/.1m. sq.

Area D2:

The salt content of the soil in area D2 is keeping seedling vigor down at this time, but we are not in danger of losing the grass stand. The biggest source of weed competition on the site is coming from bulbous bluegrass which will be going dormant in the next few weeks. I anticipate that this area will have a slow start, but will give us a successful stand of grass by fall.

Miscellaneous

I have put together an identification packet for the dominant grasses at Whitman Mission (enclosed). The packet contains grass stem characteristics that will allow us to identify the individual grasses without their seedheads.

Conclusions

[1] The grass stands that were planted last fall appear to be healthy and should be established by fall. The area that will be the slowest to become established will be Area D2.

[2] The portion of Area B that was seeded this spring is doing OK but is going to be much more dependent upon the rains that occur this growing season than the fall seedings.

[3] Weeds are going to be present in every grass seeding this year. The number of seeds that are present in the soil seed bank is quite large and we should anticipate different weed species to emerge in the grass stands after each rain this summer. Weeds such as henbit will require mowing because they are resistant to the herbicides that we have available to us. We will be able to control some of the other weeds with 2,4-D after the grass develops more.

[4] I believe that the Park Service should reconsider the possibility of using a single application of Tordon (1/4 lb/acre) as part of the seedbed preparation prior to seeding weedy areas to grass. The single application would eliminate most of the broadleaf weed seed germination problems facing Whitman Mission. We can reach our goals without the use of Tordon but it will take us longer, sacrifice grass vigor, and cost more.

(Source: Larson, L. Letter to Ed Starkey Dated April 18, 1988. Subject Whitman Mission revegetation work.)

The text of this report from Larry Larsen in 1988 describes proposed spray and seeding activities for the summer of 1988 related to Area D2:

Area D2 has fall seeding and treatments of spot mowing of cheatgrass and spray of Banvel and 2.4-D.

Conclusions: Dr. Larsen voiced concern about length of time to get approval from Washington for chemical applications, and the narrow windows of time available for effective spraying. If spraying delayed to a major degree, other treatments are estimated to cost more and be less satisfactory.

(Source: Larson, L. Project description to Dave Herrerra dated April 28, 1988 on the Whitman Mission spray program)

The purpose of this report is to provide a written record of the revegetation project at Whitman Mission during the time period April 1987 through December 1988:

Prior to 1987 the Park Service contracted with Oregon State University to develop a revegetation plan. However several revegetation failures resulted when the plan was implemented without adjusting the plan to current site conditions. As a result the current contract was adjusted so that on-site consultation would occur during the implementation of revegetation projects.

This report contains detailed observations and recommendations for areas of the park, as well as photo documentation of the ongoing treatments.

Historic Record: Area D2 contains 5-7 acres. The soil on this unit is formed from an ash deposit and are quite salty. Farming practices on this unit included the periodic flushing of the soil with irrigation water to reduce the salt content of the soil. This information in combination with observations of other ash soils in the immediate vicinity suggest that the area was originally comprised of greasewood (*Sarcobatus vermiculatus*), basin wildrye and saltgrass (*Distichlis stricta*). Previous attempts to revegetate the site with bluebunch wheatgrass (low to moderate salt tolerance) and basin wildrye (salt tolerant) have not been successful. However, it is of interest to note that scattered plants of both species could be found on the area in April 1987.

April-October Photos 1 and 2

Area D2 had been seeded the previous fall (1986) in an effort to revegetate the area. The fall seeding was in severe trouble in April due to competition by cheatgrass. Photo 1 provides an example of the cheatgrass problem. The area was mowed a number of times during the summer in an effort to save the seeding and reduce the level of seed production by the cheatgrass. Photo 2 shows the condition of the site in late August. Shortly after the picture was taken, the area was burned to begin seedbed preparation. Sprinkler irrigation was used to simulate 2 inches of precipitation and prompt cheatgrass germination. The area was sprayed in mid-September with Roundup (1 pt/A) to control the cheatgrass seedlings. A John Deere Power Seeder was used to seed the area in October to tall wheatgrass, basin wildrye, pubescent wheatgrass, and bluebunch wheatgrass. This was followed with a broadcast seeding of the area with big bluegrass and "Covar" sheep fescue (*Festuca ovina*).

November-July Photos 3 and 4

In mid-March the grass seedlings emerged on the site. Photo 3 shows seedling emergence in an area that was seeded by drilling and broadcasting. Photo 4 is an example of an area that did not receive the broadcast seeding. The seedling densities in March were:

Density (seedlings/.1 m sq)	
Wheatgrass/widlrye	7.4-11.4
Bluegrass/fescue	2.6-6.6

Cheatgrass did not become a problem on the site in 1987. However, an introduced bentgrass (*Agrostis interupta*) did compete with the seedlings. In addition the growth of the seeded grass slowed in June. This response was probably the result of two contributing factors: [1] The salty nature of the soil would have a tendency to slow the growth rate of the grass seedlings, and [2] the area had received a heavy application of Picloram (1 lb/A) several years ago. The root systems of the deeply rooted grasses may have entered a zone of salt accumulation of Picloram residue.

July-October

Area D2 had the slowest rate of stand establishment of all the areas seeded in 1987. Additional seeds will be introduced into this area in November to encourage further stand development.

(Source: Larson, L. Rangeland Resources Department, Oregon State University. Annual Report: Whitman Mission Revegetation Project. 1988)

1989 – D2

This Annual Report summarizes the recent history of the revegetation efforts in Area D2:

Area D2 contains two stages of seeded grass establishment. The largest area is in its second year of establishment and has developed rapidly after a slow year of initial growth. The grass stand is composed of tall wheatgrass, Sherman big bluegrass, Secar bluebunch wheatgrass and occasional basin wildrye. Most of this area will be fully occupied by seeded species at the end of one more growing season. Small patches of cheatgrass and spikeweed exist within this area. Sherman big bluegrass was broadcast seeded into these areas in November to speed the replacement of the weed species.

The portion of D2 that was seeded last fall is in good condition (excellent seeded grass density). The exiting grass stand should fully occupy this site by October 1990.

(Source: Larson, L. Rangeland Resources Department, Oregon State University. Whitman Mission Revegetation Annual Report; 1989. Received WHMI Dec. 20, 1989.)

This text is from a hard-backed folder labeled "Revegetation Project, and is specific to Area D2 from 1987 to 1989:

Area D2 contains 5-7 acres. The soil on this unit is from an ash deposit and is quite salty. Farming practices on this unit included the periodic flushing of the soil with irrigation water to reduce the salt content of the soil. This information, in combination with observations of other ash soils in the immediate vicinity, suggests that the area was originally comprised of greasewood, basin wildrye, and saltgrass. Previous attempts to revegetate the site with bluebunch wheatgrass (low to moderate salt tolerance) and basin wildrye (salt tolerant) have not been successful. However, it is of interest to note that scattered plants of both species could be found in the area in April, 1987.

Area was seeded with tall wheatgrass, basin wildrye, pubescent wheatgrass, bluebunch wheatgrass, big bluegrass, and Covar sheep fescue. It had a slow rate of establishment in June,

1988 because either [1] the grass roots entered a zone of salt accumulation, or, [2] the roots entered a zone of Picloram residue.

Spring 1989

This spring the grasses clearly have dominated the unit, and are well established with most grasses 4-5 feet tall.

Fall 1989. We may use some Roundup to open some patches in the grass and plant forb seed. We would do this the same time we plant forb seed in area B.

(Source: Text of 1988 Annual Report by Larry Larson is included in a hard-backed photo album labeled "Revegetation Project", and includes a page of introduction that is from 1989, as well as recommendations for 1990. This album contains numerous photos of the revegetation program and could be part of the monitoring record)

1995 – D2

An Individual Fire Report dated March 27, 1995 documents a prescribed burn of 16 acres in Area D1a, D1b, D2, and E.

(Source: WHMI. Individual Fire Report, March 27, 1995)

Area D3

1986 – D3

This report from Jim Romo to the Superintendent contains recommendations for Area D3 in 1986:

Unit D3 was burned on June 24, 1986. Applications of Roundup and Tordon 22K in the spring of 1985 eliminated forbs and quackgrass (*Agropyron repens*) over most of the area. On the southern end of D3 is a localized colony of quackgrass and colonial bentgrass (*Agrotis tenuis*). Field bindweed (*Convolvulus arvensis*) is locally abundant in the northern one-half on Unit 3. These areas should be sprayed immediately with Roundup.

Unit D3 should be prepared and seeded to Magnar basin wildrye in Fall 1986 as previously described. This unit should be mowed in the spring of 1987 before cheatgrass sets seeds. Unit 3D must not be grazed or burned for at least 3 growing seasons after seeding.

(Source: Romo, J., University of Saskatchewan. Letter and report to Robert Amdor, WHMI, dated July 7, 1986. Report is A Survey of the Revegetation Efforts at Whitman Mission National Historic Site and Recommendations for Continued Success.)

1987 – D3

The following letter in 1987 from Larry Larson to Roger Trick lists observations and recommendations for Area D3:

Area D3 was sprayed with Roundup in the fall of 1986 prior to seeding. However this site currently has a cheatgrass problem which will likely limit the success of the seeding. The

reason for the cheatgrass infestation became apparent upon a review of the precipitation records for last fall and the site descriptions provided by the staff concerning the appearance of the site at the time of the application. The fall of 1986 was quite dry from September through November. The Roundup application took place in mid-October. As a result of the lack of fall moisture, the majority of the cheatgrass seed did not germinate prior to the herbicide application. Since Roundup is only effective when it comes in contact with actively growing plant tissue, very little benefit was derived from the herbicide treatment. At this point in time the best recommendation for the site is to mow the area to a height of 4-6 inches as soon as seedheads begin to appear on the cheatgrass. This treatment will limit the seed production of the cheatgrass and at the same time weaken the plants so that the desired grass seedlings will have a better chance for survival. During mid to late summer an evaluation of this area will be made to determine if the desired grass density is sufficient to warrant spot herbicide and seeding treatment in fall or if the entire area should be treated.

(Source: Larson, L. Rangeland Resources Department, Oregon State University and O.S.U Agriculture Program, Eastern Oregon State College. Letter dated April 9, 1987 to Roger Trick, Acting Superintendent, Whitman Mission. Subject: Whitman Mission Revegetation Project).

The following memo from Larry Larson to Superintendent Herrera summarizes visits on June 10 and 16, 1987, with the following recommendations:

Areas D2 and D3 are problem areas due to cheatgrass infestations on the sites. The native grass seedlings that emerged following the seeding last fall are being severely stressed by cheatgrass competition for moisture. Since a chemical compound does not exist that is selective toward cheatgrass at this stage of grass stand development, I recommend that both areas be burned when the cheatgrass enters the red color phase (anticipated to occur prior to July 10, 1987).

A portion of D2 and D3 will be selected for fall seeding. To prepare these areas for a successful seeding they will be sprinkler irrigated in the fall with 2 applications of ½ to ¾ inches of water in early September. This treatment will ensure that adequate fall moisture is available to germinate the cheatgrass seed in the soil. In mid to late October 1987, these areas will be sprayed with Roundup to control the cheatgrass. Both areas will be drilled with a rangeland drill in late October to early November. The rangeland drill has been selected for the seeding operation for two reasons: [1] The areas will not need to be disked prior to seeding. Disking has a tendency to bring buried weed seed to the surface where it readily germinates. [2] The rangeland drill causes minimal surface disturbance and does a better job of placing the seed in the soil than a Brillion seeder, thus maximizing the opportunity for seed germination and establishment.

(Source: Larson, L., Assistant Professor of Rangeland Resources Dept., Oregon State University. Letter dated June 22, 1987 to Dave Herrera, Superintendent Whitman Mission. Subject: Whitman Mission Revegetation Project)

1988 – D3

This report from Larry Larson to Ed Starkey Dated April 18, 1988 summarizes trips made to Whitman Mission between February 25 and April 13, with observations and recommendations related to Area D3:

Area D3

This is the area that was partially roto-tilled last fall and we were concerned about the seedbed being too soft. The area was drilled with tall wheatgrass, pubescent wheatgrass, and basin wildrye. I hand broadcasted secar bluebunch, Sherman big bluegrass, and covar sheep fescue.

Seeded grass=10.4-15/.1m sq. (broadcast is spotty but represents 2-3 plants/plot)

Weeds=.6-1.8/.1m. sq. (weeds predominantly cheatgrass or quackgrass)

The soft area is coming fine and is relatively weed free. The area that was not roto-tilled has litter patches which are cold and do not have much germination. I expect them to germinate in April, these areas may require mowing due to the number of cheatgrass seedlings.

Area D3

Grass seedlings are vigorous and are at the 4-5 leaf stage. The seedlings are not quite as large as the seedlings on Area B. The only weed problem on the area at this time is in the untilled portion of the area. The untilled area has patches of mustard (not a problem) and some areas of cheatgrass (these areas are small but need to be watched). The areas of cheatgrass are associated with soil litter and do not have many grass seedlings at this time. I believe that the seedlings may have died as a result of damping off (fungus). These areas represent a small portion of the unit and may need to be seeded in the fall.

Miscellaneous

I have put together an identification packet for the dominant grasses at Whitman Mission (enclosed). The packet contains grass stem characteristics that will allow us to identify the individual grasses without their seedheads.

Conclusions

[1] The grass stands that were planted last fall appear to be healthy and should be established by fall. The area that will be the slowest to become established will be Area D2.

[2] The portion of Area B that was seeded this spring is doing OK but is going to be much more dependent upon the rains that occur this growing season than the fall seedings.

[3] Weeds are going to be present in every grass seeding this year. The number of seeds that are present in the soil seed bank is quite large and we should anticipate different weed species to emerge in the grass stands after each rain this summer. Weeds such as henbit will require mowing because they are resistant to the herbicides that we have available to us. We will be able to control some of the other weeds with 2,4-D after the grass develops more.

[4] I believe that the Park Service should reconsider the possibility of using a single application of Tordon (1/4 lb/acre) as part of the seedbed preparation prior to seeding weedy areas to grass. The single application would eliminate most of the broadleaf weed seed germination problems facing Whitman Mission. We can reach our goals without the use of Tordon but it will take us longer, sacrifice grass vigor, and cost more.

(Source: Larson, L. Report to Ed Starkey on Whitman Mission revegetation work. April 18, 1988.)

The text of this report from Larry Larson in 1988 describes proposed spray and seeding activities for the summer of 1988 related to Area D3:

Area D3 has fall seeding on tilled ground with spray treatments of Banvel, 2,4-D; on untilled ground use mowing treatments with further evaluation.

New area in D3 (north) proposes spray treatments of Round-up, Tordon, possible tillage, and seeding of grass in fall.

Conclusions: Dr. Larsen voiced concern about length of time to get approval from Washington for chemical applications, and the narrow windows of time available for effective spraying. If spraying delayed to a major degree, other treatments are estimated to cost more and be less satisfactory.

(Source: Larson, L. Letter and report to Dave Hererra, WHMI on Whitman Mission spray program, dated April 28, 1988.)

The purpose of this report is to provide a written record of the revegetation project at Whitman Mission during the time period April 1987 through December 1988:

Prior to 1987, the Park Service contracted with Oregon State University to develop a revegetation plan. However, several revegetation failures resulted when the plan was implemented without adjusting the plan to current site conditions. As a result the current contract was adjusted so that on-site consultation would occur during the implementation of revegetation projects.

This report contains detailed observations and recommendations for areas of the park, as well as photo documentation of the ongoing treatments.

Historic Record: D3

The historic record and soil information indicate that this area contained scattered patches of basin wildrye in an area dominated by mid to short grasses.

<u>April-October</u> Photo 1:

Area D3 was seeded in 1986 with a mixture of Basin wildrye and bluebunch wheatgrass. However, attempts to control the competing vegetation were unsuccessful and the seeding had little chance for success. Photo 1 shows the extent of weed competition in April. The competing vegetation was composed of cheatgrass, Bermuda grass (*Cynodon dactylon*), and quackgrass (*A. repens*). The area was mowed periodically during the summer to control seed production of weeds and the seeding was determined to be a failure in late July.

<u>August-February</u> Photo 2

The area was sprinkler irrigated in late August to simulate late summer rains. This was done to encourage the weedy species into an active stage of growth so that they could be controlled chemically. In mid-September the area was treated with Roundup (1 qt/A) to control the weed species. The portion of the area that was dominated by quackgrass and Bermuda grass was tilled in late September to break up the soil and expose the root systems. In October the

tilled areas were packed and the entire unit was drilled (Photo 2) with a mixture of tall wheatgrass, basin wildrye, pubescent wheatgrass, and bluebunch wheatgrass and then the area was broadcast seeded with big bluegrass and sheep fescue.

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The grass area behind the headquarters building is a remnant of an irrigated tame pasture that is dominated by tall fescue (*Festuca arundinacea*). Photo 3 was taken in June 1987. The grass stand was stagnating and weeds were beginning to encroach into the area. The area was spot treated with Banvel and fertilized in 1988. The grass stand is responding to the treatment and should close the area to weed invasion until Phase 2 is initiated in the area.

(Source: Larson, L. Annual Report, 1988. Rangeland Resources Department, Oregon State University. Whitman Mission Revegetation Project.)

1989 – D3

This Annual Report provides a detailed summary of recent history of the revegetation program for Area D3:

Area D3 was seeded in the fall of 1987 and 1988. The portion of D3 that was seeded in 1987 is established. Small patches of wild lettuce currently exist in this unit. These areas were broadcast seeded with Sherman big bluegrass in November to improve grass establishment.

The portion of D3 that was seeded last fall yielded a mixture of successes and failures. Approximately 80 percent of the area contains a good stand of grass. The reason for the localized failures in this seeding is that the seedbed prescription (tillage) brought annual grass seed (*Hordeum*) to the surface, where it germinated and competed heavily with the desired grass seedlings. The application of Tordon the previous fall controlled broadleaf competition in this unit. Unfortunately, Tordon does not control annual grass competition.

The patches of poor grass establishment in D3 will be monitored in February to determine if an application of Roundup with a follow-up spring seeding will stabilize the area.

(Source: Larson, L. Rangeland Resources Department, Oregon State University. Whitman Mission Revegetation Annual Report; 1989. Received WHMI Dec. 20, 1989.)

This text is from a hard-backed folder labeled “Revegetation Project, and includes a discussion of observations from 1987 through 1989 specific to Area D3:

The historic record and soil information suggest that this area contained scattered patches of basin wildrye in an area dominated by mid to short grasses.

Fall 1986 - Planted with basin wildrye and bluebunch wheatgrass. By July, 1987, it was clear that the planting had failed.

October 1987 - Planted with tall wheatgrass, basin wildrye, pubescent wheatgrass, bluebunch wheatgrass, big bluegrass, and sheep fescue.

July 1988 - Approximately 75 percent of the area had sparse stands of grass, but it was decided to till and replant all but 25 percent of this unit.

Fall 1988 - 75 percent of the unit was replanted with the same seed mix as the October 1987 planting.

Summer 1989 - Most of the area has a thin established stand, with cheatgrass between the taller grasses.

Plans:
1989: Let the grasses grow.
1990: Let the grasses grow, and monitor the cheatgrass populations. We expect our planted grass species to grow thicker and begin to dominate the cheatgrass in 1990.

(Source: Text of 1988 Annual Report by Larry Larson is included in a hard-backed photo album labeled "Revegetation Project", and includes a page of introduction that is from 1989, as well as recommendations for 1990. This album contains numerous photos of the revegetation program and could be part of the monitoring record)

1997 – D3

An Individual Fire Report dated March 25, 1997 documents a prescribed burn of 13 acres in Areas D3 and E.

(Source: WHMI. Individual Fire Report, March 25, 1997)

Area D4A

1986 – D4A

This report from Jim Romo to the Superintendent lists the recommendation for Area D4A in 1986:

Unit D4A should be burned in early spring 1987. (Note Roger Trick 8/19/02 confirms this was done)

(Source: Romo, J. University of Saskatchewan, to Robert Amdor, WHMI. Letter and report dated July 7, 1986. Report is A Survey of the Revegetation Efforts at Whitman Mission National Historic Site and Recommendations for Continued Success.)

An Individual Fire Report dated March 9, 1987 documents a prescribed burn of 2 acres in Areas D4A and D4B.

(Source: WHMI. Individual Fire Report, March 9, 1987)

Area D4B

1986 – D4B

This report from Jim Romo to the Superintendent lists recommendations for Area D4B in 1986:

Unit D4B should be burned in early Spring 1987. Banvel must be applied while poison hemlock and teasel are in the rosette stage in Spring 1987. (Note: Roger Trick 8/19/02 confirms this was done)

Weeds that survive this herbicide treatment should be mowed before they set seed in 1987. This unit should be disked in Fall of 1987 and seeded as previously recommended. Unit D4B should not be grazed or burned for at least 3 years following seeding. Weeds should be mowed as the height of 4-6 inches before they set seed during the first 2 years after seeding. (Note: Roger Trick 8/19/02 says that this was not done)

(Source: Romo, J. University of Saskatchewan, to Robert Amdor, WHMI. Letter and report dated July 7, 1986. Report is A Survey of the Revegetation Efforts at Whitman Mission National Historic Site and Recommendations for Continued Success.)

1987 – D4B

An Individual Fire Report dated March 9, 1987 documents a prescribed burn of 2 acres in Areas D4A and D4B.

(Source: Individual Fire Report, March 9, 1987)

Area D4C

1986 – D4C

This report from Jim Romo to the Superintendent lists recommendations for Area D4C in 1986:

Unit D4C should be mowed as soon as possible to limit seed production by poison hemlock, teasel (*Dipsacus sylvestris*), and yellow starthistle. This unit should be burned in spring 1987 and Banvel applied to control the above mentioned weeds. Banvel should be reapplied in spring 1988 (Note: Roger Trick 8/19/01 confirms this was done)

The unit should be burned when cheatgrass is mature in 1988. As previously recommended, containerized seedlings should be planted in spring 1989. After containerized seedling are planted, the area should be mowed at a height of 4 to 6 inches before weeds set seed. (Note: Roger Trick 8/19/02 says this part of the recommendation was not done).

(Source: Romo, J., University of Saskatchewan. Letter and report to Robert Amdor, WHMI, dated July 7, 1986. Report is A Survey of the Revegetation Efforts at Whitman Mission National Historic Site and Recommendations for Continued Success.)

Area E

1984 - E

This early 1984 report divides the park into six land units, including Area E, and contains recommendations for treatment:

Area E includes seven acres of land in the center portion of the park which includes the visitor center, roads, and parking areas. Alternatives for this land unit are [1] Restore native vegetation. This area has been heavily modified to the extent that all but vestiges of native vegetation have been removed. Restoration is not achievable, nor is it necessarily desirable. [2] Maintain current vegetation cover, but control noxious weeds and undesirable plant and animal species.

(Source: Gilbert, C.A., USDI National Park Service, 1984. Landscape Study and Management Alternatives for Revegetation, Whitman Mission National Historical Site. National Park Service Interdisciplinary Study by the Pacific Northwest Regional Division of Cultural Resources, Science and Technology, Resource Management.)

This Draft Task directive sets early direction in 1984 for Area E:

Area [E] This is the contemporary developed area of the park, including maintenance, housing, the visitor center, picnic areas and parking. This area will remain in its current condition. RC will provide brief design/planting guidelines for appropriate replacement, screening and other landscape concerns and will pay particular attention to the park entry.

(Source: Amdor, R. Draft Task Directive: WHMI Landscape/Revegetation Schematics. Handwritten date 1984.)

1986 - E

An Individual Fire Report dated March 11, 1986 documents a prescribed burn of 10 acres in Areas E and F1.

(Source: WHMI. Individual Fire Report, March 11, 1986)

This report from Jim Romo to the Superintendent in 1986 contains observations and recommendations for Area E:

Unit E was burned in spring 1986 and localized patches of cheatgrass were burned on June 24, 1986. The perennial grasses basin wildrye, tall wheatgrass (*Agropyron elongatum*), and intermediate wheatgrass (*Agropyron intermedium*) are present in this unit and density of perennial grasses should be increased. The eastern and upper portion of this unit where successfully burned should be lightly scarified in Fall 1986 and Magnar basin wildrye planted. This unit should be mowed at a height of approximately 4 to 6 inches in early June 1987. Unit E should not be grazed or burned for at least 3 years following seeding.

(Source: Romo, J. , University of Saskatchewan, to Robert Amdor, WHMI. Letter and report dated July 7, 1986. Report is A Survey of the Revegetation Efforts at Whitman Mission National Historic Site and Recommendations for Continued Success.)

1988 - E

This report from Larry Larson to Ed Starkey Dated April 18, 1988 summarizes trips made to Whitman Mission between February 25 and April 13, with observations and recommendations related to Area E and F:

February 25:

Grass seedlings approximately 1-2 inches in height were observed on all of the areas that had been seeded in the fall. Weed competition was at a minimum and areas with colder soils (litter and/or more soil water) had fewer grass seedlings at that time.

March 8

Recommend that Areas E & F be burned or mowed and that Area F be fertilized at a rate of 25-30 lbs. of nitrogen per acre to improve the vigor of the existing grass stand.

(Source: Larson, L. Letter and Report to Ed Starkey Dated April 18, 1988. Subject Whitman Mission revegetation work.)

The text of this report from Larry Larson in 1988 describes proposed spray and seeding activities for the summer of 1988 related to Area E:

Areas E and F propose spot spraying weeds with Banvel, or 2,4-D depending on species. Prepare sprayed areas for fall seeding.

Conclusions: Dr. Larson voiced concern about length of time to get approval from Washington for chemical applications, and the narrow windows of time available for effective spraying. If spraying delayed to a major degree, other treatments are estimated to cost more and be less satisfactory.

(Source: Larson, L. Letter and report to Dave Herrerra, WHMI on Whitman Mission spray program, dated April 28, 1988.)

1989 - E

This is from the Annual Report from 1989:

This prescription applies to 7 acres; the unit between the visitor center and the maintenance complex, and various miscellaneous areas around the park that were not treated during phase 1. These areas were tilled in October and will be checked for annual weed invasion in February. If annual weeds are present the area will be sprayed with roundup at the rate of 1 pt ae/A. The area will be drilled and broadcast seeded in late February or early March. The drill seed mix for the low sites will consist of Magnar basin wildlrye, Secar bluebunch wheatgrass, and Whitmar bluebunch wheatgrass. The upper areas will be drilled with a mixture of Secar bluebunch wheatgrass, Whitmar bluebunch wheatgrass, and Critana thickspike wheatgrass. Then the entire area will be broadcast seeded with a mixture of Sherman big bluegrass and Covar sheep fescue.

ENTRANCE ROAD: The entrance road was redone in the summer of 1989 and the area adjacent to the pavement were seeded (1.2 A) in November. The borrow pits on both sides of the road were hydro-seeded using two passes. The first pass deposited the seed with a light coating of colored wood fiber. The second pass covered the seed with a wood fiber mulch and tackifier (2000 lbs/A). Two sites exist within each borrow pit: 1) The area next to the asphalt which is a constructed roadbase with a "soil" varying in depth from ½ to 4 inches in depth over laying a rock/dirt base, and 2) the area extending from the roadbase to the fence line which was relatively undisturbed during road construction. Area 1 presents a sloping surface that will be dry due to surface water run-off, low in nutrients, and compacted. This area was roughened with a harrow prior to seeding. The seed mix consisted of Covar sheep fescue, Sherman big bluegrass, Critana thickspike wheatgrass, and Sodar streambank wheatgrass seeded at the rate or 30 lb/A. Area 2 was sprayed with roundup at the rate of 1 qt ae/A followed by tillage to prepare a seedbed. This area receives the benefit of surface water run-on and will support basin wildrye. The seed mix consisted of Magnar basin wildrye, Secar bluebunch wheatgrass, Whitmar bluebunch wheatgrass and Sherman big bluegrass seeded at the rate of 30 lb/A. A spring application of glean may be necessary on area 2 if weeds become a problem and a light application of fertilizer may be necessary on area 1 if grass growth is slow.

(Source: Whitman Mission Annual Report: 1989. Larry Larson, Oregon State University. Received WHMI Dec. 20, 1989)

1990 - E

This is from the 1990 Annual Report:
The entrance road was hydroseeded in 1989. Seedling establishment developed as well as could be expected given the harshness of the roadbed environment. The seedbed 6 ft on either side of the asphalt is compacted roadbed material with a low amount of fertility. A stand of native grass is becoming established on the north side of the road and will not require much additional effort in 1991. The grass stand, when fully established, will visibly thin in structure and biomass as the asphalt is approached. Consequently I do not believe that the road side community will be a weed-free environment but the dominant vegetation should be native. The south side of the road is a harsher environment than the north side due to increased solar radiation. Grass seeds germinated in this environment but a number of seedlings succumbed to drought conditions during the initial stages of establishment. The south side of the road was broadcast seeded with Covar sheep fescue in the fall of 1990 to supplement the grass population. Chemical weed control may be required during the 1991growing season if a weed population develops on the roadbed.
(Source: Annual Report, 1990. Whitman Mission Revegetation Project. Larry Larson, Oregon State University)

1993 – E

The following if from a status report:

Dead Grass Stand Behind Revegetation Sign

The stand of bluebunch wheatgrass that died behind the stand of basin wildrye needs to be reseeded. The weed residue should be burned to clean the area for tillage. In the spring you

should till the site and drill the area with basin wildrye. You should also anticipate the need for an application of Glean to clean up the grass seeding of weed competition.

Quackgrass area south of the visitor center

You are on the right track with regard to the development of patches of basin wildrye. However, you should not seed those areas until you have eliminated the quackgrass rhizomes. I suggest that you lightly fertilize the patches so that you maximize the growth of the rhizome sprouts in the spring. Once the sprouts are actively growing they will be susceptible to Roundup at the rate of 1 quart per acre. You can seed the area following the spray treatment but you may have to water the grass periodically while they become established. I point this out because the seeding may occur in the late spring for dependable precipitation.

(Source: Report on Status of Revegetation Effort. December 13, 1993. Larry Larson, Oregon State University to Roger Trick)

1995 - E

An Individual Fire Report dated March 27, 1995 documents a prescribed burn of 16 acres in Area D1a, D1b, D2, and E.

(Source:WHMI. Individual Fire Report, March 27, 1995)

1997 - E

An Individual Fire Report dated March 25, 1997 documents a prescribed burn of 13 acres in Areas D3 and E.

(Source: WHMI. Individual Fire Report, March 25, 1997)

1999 - E

An Individual Fire Report dated March 11, 1999 documents a prescribed burn of 10 acres in Areas E and F1.

(Source: WHMI. Individual Fire Report, March 11, 1999)

Area F

1984 - F

This early 1984 report divides the park into six land units, including Area F, with recommendations:

Area F includes approximately seven acres and constitutes the historic core of the site. Alternatives for this land unit are [1] Restore native vegetation. Because of the large numbers of visitors, complete restoration is largely impossible, and may be undesirable, [2] Maintain the core area as is currently being done.

(Source: Gilbert, C.A. USDI National Park Service, 1984. Landscape Study and Management Alternatives for Revegetation, Whitman Mission National Historic Site. National

Park Service Interdisciplinary Study by the Pacific Northwest Regional Division of Cultural Resources, Science and Technology, Resource Management.)

This early Draft Task directive from 1984, contains direction for Area F:

Area [F] This is the historic core of the park. RC will develop schematic design for appropriate option to existing condition that will increase visitor appreciation for the Whitman experience. RC will assure that landscape/revegetation directions for this area blend carefully and comfortably with surrounding areas. Science will provide consulting guidance to CR for vegetation concerns. WHMI will provide consulting guidance to CR for visitor experience concerns.

(Source: Amdor, R.C. Draft Task Directive: WHMI Landscape/Revegetation Schematics. Handwritten, dated 1984.)

1988 - F

This report from Larry Larson to Ed Starkey Dated April 18, 1988 summarizes trips made to Whitman Mission between February 25 and April 13, with observations and recommendations related to Area E and F:

February 25:

Grass seedlings approximately 1-2 inches in height were observed on all of the areas that had been seeded in the fall. Weed competition was at a minimum and areas with colder soils (litter and/or more soil water) had fewer grass seedlings at that time.

March 8

Recommend that Areas E & F be burned or mowed and that Area F be fertilized at a rate of 25-30 lbs. of nitrogen per acre to improve the vigor of the existing grass stand.

(Source: Letter and Report from Larry Larson to Ed Starkey Dated April 18, 1988. Subject Whitman Mission revegetation work.)

The text of this report from Larry Larsen in 1988 describes proposed spray and seeding activities for the summer of 1988 related to Area F:

Areas E and F propose spot spraying weeds with Banvel, or 2,4-D depending on species. Prepare sprayed areas for fall seeding.

Conclusions: Dr. Larsen voiced concern about length of time to get approval from Washington for chemical applications, and the narrow windows of time available for effective spraying. If spraying delayed to a major degree, other treatments are estimated to cost more and be less satisfactory.

(Source: Project description dated April 28, 1988 on the Whitman Mission spray program From Dr. Larry Larson.)

1989 - F

The pond unit contains two management areas; [1] the west side of the pond that was seeded last year and will receive intensive management because it is next to the lawn, and [2] the east side of the pond which will be maintained in a natural condition and has not received any revegetation treatments.

The west side of the pond was broadcast seeded with Sodar streambank wheatgrass and Sherman big bluegrass after the pond bank was reconstructed. Four clumps of rush/bulrush sod were planted at the waters' edge last fall. An acceptable grass stand became established on the pond bank and should continue to occupy the site. This grass stand contains areas of Italian ryegrass, Kentucky bluegrass and Bermuda grass (lawn grasses) which have become established in the openings of the native grass stand. At the waters edge the transplants of rush/bulrush sod have become established and should spread along the pond boundary. The east side of the pond is benefiting from the seed drop occurring in area B along the old river channel. Reed canarygrass and rushes are moving into this area. In addition native species of goldenrod, smartweed, and cattail are growing on the site. I recommend that the area be broadcast seeded in February with reed canarygrass and Sherman big bluegrass with follow-up spot treatments of herbicides in the spring to encourage the process of natural succession.

(Source: Whitman Mission Annual Report: 1989. Larry Larson, Oregon State University. Received WHMI Dec. 20, 1989)

Area F1

1986 – F1

An Individual Fire Report dated March 11, 1986 documents a prescribed burn of 10 acres in Areas E and F1.

(Source: Individual Fire Report, March 11, 1986)

This report from Jim Romo to the Superintendent in 1986 contains observations and recommendations for treatment of Area F1:

Unit F1 was burned in Spring 1986. Weeds have been reduced by this burning and vigor of perennial grasses is high. This area should not be burned until early spring 1989. A 3-year period between fires will allow perennial grasses to express their competitive ability against weeds.

Localized colonies of Canada thistle (*Cirsium arvense*) should be mowed to prevent seed production and then treated in Fall of 1986 and Spring 1987 with Banvel or 2,4-D. These herbicide applications should reduce the vigor of Canada thistle and allow the perennial grasses to invade and compete with it.

Poison hemlock and teasel are present near the Old Oregon Trail; these weeds should be cut at ground level in 1986 and 1987 and removed before they set seed. Preventing seed production and removal of teasel and poison hemlock will enable the perennial grasses to grow, compete, and suppress these weedy species.

(Source: Letter and report from Jim Romo of University of Saskatchewan, to Robert Amdor, WHMI, dated July 7, 1986. Report is A Survey of the Revegetation Efforts at Whitman Mission National Historic Site and Recommendations for Continued Success.)

1990 – F1

This letter makes observations and recommendations specifically about Area F1:

A native grass seeding is scheduled to occur on the fescue field (figure 2: unit F1) . The field needs to be placed on a seedbed preparation schedule that will permit seeding (drill) next March. This will require the eradication of existing vegetation. The best option for achieving this goal will be to spray the field with Roundup at a rate of 1 qt/A applied in September when the plants are in fall regrowth. After 2 weeks the field should be tilled, except for the existing islands of native vegetation. The field will be monitored in February to determine if the application of 1 pt/A of Roundup will be necessary for weed control prior to seeding. The drill mix will consist of Magnar basin wildrye, Secar bluebunch wheatgrass, Whitmar bluebunch wheatgrass, and Critana thickspike wheatgrass. A broadcast seeding will follow applying Sherman big bluegrass to upland sites and reed canarygrass to the wettest areas. The biggest concern with this area will be the control of quackgrass and tall fescue. Failure to control these species will severely limit our abilities to establish a native stand of grass. This area should be established by the end of the 1991 growing season.

(Source: Letter from Larry Larson to Terry Darby WHMI dated August 13, 1990. Subject Whitman Mission Vegetation Maintenance Program [3 year]).

The following is from the 1990 Annual Report:

A second native grass seeding (drill) is scheduled for the fescue field (Figure 2: unit F1) in March 1991. The field was tilled in the fall of 1990 and will be left fallow until 2-3 weeks prior to the seeding. At that time the field will be evaluated to determine areas requiring an application of roundup (1 qt/A) to control volunteer quackgrass and tall fescue. The field will be planted with a number of seed mixes in order to establish a mosaic of native plant communities. A reed canarygrass seed mix will be seeded in the wettest areas of the field with basin wildrye seed mixes planted in the remaining lowland sites. Upland areas and stringer communities will be established with big bluegrass and bunchgrass wheatgrass seed mixes to complement the community mosaic and blend this seeding with the 1990 native seedings on the miscellaneous area. The island seedings established in the fescue field in 1990 (1989 annual report) were saved and incorporated into the community mosaic.

(Source: Annual Report, 1990. Whitman Mission Revegetation Project. Larry Larson, Oregon State University)

1999 – F1

An Individual Fire Report dated March 11, 1999 documents a prescribed burn of 10 acres in Areas E and F1.

(Source: Individual Fire Report, March 11, 1999)

Area F2

1986 – F2

This report from Jim Romo to the Superintendent in 1986 contains observations and recommendations for Area F2:

The area north, south and east of the intensively managed turf in Unit F2 should be burned as early as possible in spring 1987. This burning will enhance the vigor of perennial grasses and suppress weedy species.

Within Unit F2 are localized colonies of Canada thistle. After prescribed burning, these Canada thistle colonies should be sprayed with Banvel or 2,4-D. The release of grasses by burning and the suppression of Canada thistle with herbicides should result in improved perennial grass cover and reduced weed densities.

(Source: Letter and report from Jim Romo of University of Saskatchewan, to Robert Amdor, WHMI, dated July 7, 1986. Report is A Survey of the Revegetation Efforts at Whitman Mission National Historic Site and Recommendations for Continued Success.)

Area G

1990 – G

This letter makes recommendations for Area G:

An area of 500 sq. ft. will be set aside in the fescue field as a nursery (figure 2; unit G) for the establishment of native forb and shrub species. The area will be used to germinate and establish plants that can be transplanted the following fall or spring. Seeds purchased in 1990 will be used to initiate this program next spring. This program will be needed for a minimum of 4 years.

(Source: Letter from Larry Larson to Terry Darbey WHMI dated August 13, 1990. Subject Whitman Mission Vegetation Maintenance Program [year]).

The following is from the 1990 Annual Report:

> An area of 500 sq ft will be set aside in the fescue field to establish a native forb and shrub garden (figure 2: unit G). The area will need to receive intensive weed management and be used to develop transplant stock for native forb and shrub species. Seeds purchased in 1990 will be used to initiate this program in March 1991. The garden will be used for a minimum of 4 years.

(Source: Annual Report, 1990 Whitman Mission Revegetation Project. Larry Larson, Oregon State University)

Area H

Beginning in 1990, Area H, and H1-H6 were assigned the land on and adjacent to Shaft Hill, sometimes overlapping earlier Area C.

1989 - H

The following is from the 1989 Annual Report:

A four acre area of the hill will be revegetated in late February or early March, 1990. The area includes the area that was accidentally burned last year (south aspect) and a section of land on top of the hill. The top of the hill will be burned in an irregular pattern this fall. In February the burned area and the south aspect will be sprayed with roundup at the rate of 1 pt ae/A to clear the area of annual grass competition. Both areas will be broadcast seeded (30 lb/A) and mulched with clean straw (minimal weed and wheat seed) at the rate of 500 lbs/A. The seed mix will consist of Sherman big bluegrass, Critana thickspike wheatgrass, Secar bluebunch wheatgrass, Sodar stareambank wheatgrass, and sand dropseed. A spring application of glean will probably be required to control yellow starthistle seedlings in the seeding.

Tublings of green and gray rabbitbrush will be planted in clumps on the top and side of the hill. The shrub plantings will be flagged for monitoring purposes.

(Source: Annual Report 1989. Larry Larson. Received WHMI Dec. 20, 1989)

1990 - H

This letter makes observations and recommendations regarding Unit H:

The Hill (Figure 2: units H-1-6) represents a harsh environment with numerous exotic weed species. Unit H5 was seeded last Feb/Mar and has grass seedlings growing on the area. These seedlings are not established and will require the completion of the 1991 growing season before the quality of the grass stand can be assessed. As an insurance policy I propose that we broadcast seed ½ of this unit in the fall to determine if a double seeding will improve the quality of the grass stand in 1991. Units H1 and 6 should be burned this fall to remove weed residue, and help prepare the seedbed. The units will be monitored in February to determine when an application of 1 pt/A of roundup should be applied to control annual weeds. Unit H6 will be drilled in March with Secar and Whitmar bluebunch wheatgrass, and Nezpar Indian ricegrass. This will be followed with a broadcast seeding of Sherman big bluegrass, Covar sheep fescue, and sand dropseed. Unit H1 will be broadcast seeded with a similar seed mix followed with a straw mulch. If a grass stand begins in the spring and is threatened by weed encroachment it may be necessary to control the weeds with gleam. The cost of spraying with Glean will be the loss of perennial buckwheat plants that currently occupy portions of the hill..

Units H2, 3 and 4 will be scheduled for a spring 1992 seeding so that we can benefit from the knowledge gained with the proposed seedings.

(Source: Letter from Larry Larson to Terry Darbey WHMI dated August 13, 1990. Subject Whitman Mission Vegetation Maintenance Program [3 year]).

Area H1

1990 – H1

This letter makes observations and recommendations regarding Unit H1 as follows:

The Hill (Figure 2: units H-1-6) represents a harsh environment with numerous exotic weed species. Unit H1 will be broadcast seeded with a similar seed mix followed with a straw mulch. If a grass stand begins in the spring and is threatened by weed encroachment it may be necessary to control the weeds with Gleam. The cost of spraying with glean will be the loss of perennial buckwheat plants that currently occupy portions of the hill.

(Source: Letter from Larry Larson to Terry Darby WHMI dated August 13, 1990. Subject Whitman Mission Vegetation Maintenance Program [3 year]).

1993 – H1

The following is from a status report:

My overall impression of the vegetation management is positive and I offer the following prescriptions as a suggested course of action.

[1] Top of Hill—The seeding on top of the hill is actually quite good. This past growing season yielded a bumper starthistle crop throughout eastern Washington and Oregon so you should not be surprises that starthistle over-topped your seeding. The key to assessing that kind of a seeding is to evaluate grass seedling density and survivorship. Nearly 75-80 percent of the area has an adequate density of grass seedlings. The majority of the seedlings are "Covar" sheep fescue. This is good because Covar has been shown to be one of the most aggressive species in choking out starthistle. Unfortunately, Covar is slow to establish and that is why you had so much starthistle this year. In years 2 and 3 you will see a dramatic drop in starthistle. The top of the hill will never be starthistle-free but the density of this grass stand should allow only scattered starthistle plants in the future.

In the 20-25 percent of the area that lacks an adequate grass seedling density I offer 2 prescriptions: [a] In areas where the grass density is nearly adequate, broadcast additional Covar seed this winter. If possible, do it before a storm so that the rain or snow will improve seed to soil contact, and [b] In areas that show marginal seedling survival lightly harrow the spot and broadcast a mix of Covar and Sherman big bluegrass. Once again, if possible, schedule the seeding before a storm so that the seed has the greatest chance of being covered with a small amount of soil. I would not recommend tearing any part of the hill up and starting over—give the grass stand a chance to become fully established.

(Source: Report on Status of Revegetation Effort. December 13, 1993. Larry Larson to Roger Trick)

Area H2

1990 – H2

This letter makes observations and recommendations regarding Unit H2:

The Hill (Figure 2: units H-1-6) represents a harsh environment with numerous exotic weed species. Units H2, 3 and 4 will be scheduled for a spring 1992 seeding so that we can benefit from the knowledge gained with the proposed seedings.

(Source: Letter from Larry Larson to Terry Darbey WHMI dated August 13, 1990. Subject Whitman Mission Vegetation Maintenance Program [3 year]).

1993 – H2

The following is from a status report:

North Slope of Hill

I suggest that you select a small area close to the top of the hill. Burn the annual grass residue off of the site. Monitor the site into February and if a significant number of annual grasses emerge—spray them with round-up at the rate of 1 pt/A. Broadcast seed the area with a mix of Covar sheep fescue and Sherman big bluegrass by mid-March. This portion of the hill should not be difficult to get a stand of grass established if you can keep the annual grass under control. The other possible danger is from starthistle which may have a significant soil seed bank—if so you will need to spray with Glean in the spring. The fire will not hurt the existing shrub population, they are all capable of sprouting from the crown or root stock. As a word of caution, I would not burn a large amount of the hill at any one time due to the amount of fuel.

(Source: Report on Status Report on Revegetation Effort, December 13, 1993. From Larry Larson to Roger Trick)

Area H3

1990 – H3

This letter makes observations and recommendations regarding Unit H3:

The Hill (Figure 2: units H-1-6) represents a harsh environment with numerous exotic weed species. Units H2, 3 and 4 will be scheduled for a spring 1992 seeding so that we can benefit from the knowledge gained with the proposed seedings.

(Source: Letter from Larry Larson to Terry Darbey WHMI dated August 13, 1990. Subject Whitman Mission Vegetation Maintenance Program [3 year]).

1993 – H3

The following is from a status report:

North Slope of Hill

I suggest that you select a small area close to the top of the hill. Burn the annual grass residue off of the site. Monitor the site into February and if a significant number of annual grasses emerge—spray them with round-up at the rate of 1 pt/A. Broadcast seed the area with a mix of Covar sheep fescue and Sherman big bluegrass by mid-March. This portion of the hill should not be difficult to get a stand of grass established if you can keep the annual grass under control. The other possible danger is from starthistle which may have a significant soil seed bank—if so you will need to spray with glean in the spring. The fire will not hurt the existing shrub population, they are all capable of sprouting from the crown or root stock. As a word of caution, I would not burn a large amount of the hill at any one time due to the amount of fuel.

(Source: Report on Status Report on Revegetation Effort, December 13, 1993. From Larry Larson to Roger Trick)

Area H4

1990 – H4

This letter makes observations and recommendations regarding Unit H4:

The Hill (Figure 2: units H-1-6) represents a harsh environment with numerous exotic weed species. Units H2, 3 and 4 will be scheduled for a spring 1992 seeding so that we can benefit from the knowledge gained with the proposed seedings.

(Source: Letter from Larry Larson to Terry Darbey WHMI dated August 13, 1990. Subject Whitman Mission Vegetation Maintenance Program [3 year]).

1993 – H4

The following is from a status report:

North Slope of Hill

I suggest that you select a small area close to the top of the hill. Burn the annual grass residue off of the site. Monitor the site into February and if a significant number of annual grasses emerge—spray them with round-up at the rate of 1 pt/A. Broadcast seed the area with a mix of Covar sheep fescue and Sherman big bluegrass by mid-March. This portion of the hill should not be difficult to get a stand of grass established if you can keep the annual grass under control. The other possible danger is from starthistle which may have a significant soil seed bank—if so you will need to spray with glean in the spring. The fire will not hurt the existing shrub population, they are all capable of sprouting from the crown or root stock. As a word of caution, I would not burn a large amount of the hill at any one time due to the amount of fuel.

(Source: Report on Status Report on Revegetation Effort, December 13, 1993. From Larry Larson to Roger Trick)

Area H5

1990 – H5

This letter makes observations and recommendations regarding Unit H5:

The Hill (Figure 2: units H-1-6) represents a harsh environment with numerous exotic weed species. Unit H5 was seeded last Feb/Mar and has grass seedlings growing on the area. These seedlings are not established and will require the completion of the 1991 growing season before the quality of the grass stand can be assessed. As an insurance policy I propose that we broadcast seed ½ of this unit in the fall to determine if a double seeding will improve the quality of the grass stand in 1991.

(Source: Letter from Larry Larson to Terry Darbey WHMI dated August 13, 1990. Subject Whitman Mission Vegetation Maintenance Program [3 year]).

The following is from the 1990 Annual Report:

Hill unit activities (1989 annual report) did not develop according to our 1989 workplan due to logistics problems relating to weather and equipment. The current program consists of burning the top of the hill (figure 2; unit H6) during the winter of 1990/91, followed by an application of Roundup (1 pt/A) in early spring to control yellow starthistle seedings. The area will be seeded (drilled) in March to native bunchgrass species. The south aspect of the hill (figure 2, unit H5) was prepared and seeded according to the schedule described in the 1989 annual report. These efforts resulted in a modest stand of native grass. A supplemental broadcast seeding of the south aspect unit was made in the fall of 1990 and should facilitate the establishment of native grasses.

(Source: Annual Report, 1990. Whitman Mission Revegetation Project. Larry Larson, Oregon State University)

Area H6

1990 – H6

This letter makes observations and recommendations regarding Unit H6:

The Hill (Figure 2: units H-1-6) represents a harsh environment with numerous exotic weed species. Units H1 and 6 should be burned this fall to remove weed residue, and help prepare the seedbed. The units will be monitored in February to determine when an application of 1 pt/A of Roundup should be applied to control annual weeds. Unit H6 will be drilled in March with Secar and Whitmar bluebunch wheatgrass, and Nezpar Indian ricegrass. This will be followed with a broadcast seeding of Sherman big bluegrass, Covar sheep fescue, and sand dropseed.

(Source: Letter from Larry Larson to Terry Darbey WHMI dated August 13, 1990. Subject Whitman Mission Vegetation Maintenance Program [3 year]).

The following is from the 1990 Annual Report:

Hill unit activities (1989 annual report) did not develop according to our 1989 workplan due to logistics problems relating to weather and equipment. The current program consists of burning the top of the hill (figure 2; unit H6) during the winter of 1990/91, followed by an application of roundup (1 pt/A) in early spring to control yellow starthistle seedings. The area will be seeded (drilled) in March to native bunchgrass species. The south aspect of the hill (figure 2, unit H5) was prepared and seeded according to the schedule described in the 1989 annual report. These efforts resulted in a modest stand of native grass. A supplemental broadcast seeding of the south aspect unit was made in the fall of 1990 and should facilitate the establishment of native grasses.

(Source: Annual Report, 1990. Whitman Mission Revegetation Project. Larry Larson, Oregon State University)

Appendix B

General Reports and Area Non-specific Recommendations

Memo from Larry Larson, Assistant Professor, Rangeland Resources Department, Oregon State University dated August 14, 1987 to Dave Herrera, Superintendent Whitman Mission.

Subject: Whitman Mission Revegetation Project

The following memo outlines the status of the revegetation project through the month of July that resulted from telephone conversations and one site visit.

Site Preparation: Site Preparation work described in the June 22 memo is on schedule.

Biological Control Agent: The hemlock moth that I mentioned in the June 22 memo is called *Aganopterix alstoemeriana*. The moth is already known to occur in Walla Walla County and is being released in other Washington counties for the specific control of hemlock. The release process involves the collection of infected plants in early May and placing them in the vicinity of the hemlock you wish to destroy. When the larvae emerge from the host plants, the moth travels to new plants and infect the new population. To get some assistance in this area, you should contact the following people:

Mr. John Cato
Weed Supervisor Walla Walla County
527-3246
or
Dr. Gary Piper
Washington State University

Seed mix: The following is a rough calculation of the amount of seed that needs to be purchased to plant area B and portions of areas D2 and D3. These calculations will have to be refined when the quality of the seed purchased is known. In addition, the calculations are based on the assumption of planting 10-12 lbs of seed per acre.

Area B: 28 acres total

8 acres in shallow draws will be seeded with the following species:

Canary reed grass "Vantage" (native)	16 lbs
Big bluegrass "Sherman" (native)	16 lbs
Tall wheatgrass "Largo" (introduced)	64 lbs

20 acres in the upland areas (Area B) will be seeded with the following species:

Tall wheatgrass "Largo" (introduced)	120 lbs
Sheep fescue "Covar" (native)	40 lbs
Big bluegrass "Sherman" (native)	40 lbs

Areas D2 and D3

10 acres will be planted with the following species:

Tall wheatgrass "Largo (introduced)	60 lbs
Basin wildrye "Magnar" (native)	20 lbs
Sheep fescue "Covar" (native)	10 lbs
Bluebunch wheatgrass "Whitmar" (native)	20 lbs
Pubescent wheatgrass "Luna" (introduced)	20 lbs

The local Soil Conservation Service Office should be able to give you assistance in locating sources for the purchase of the grass seed.

Grass drill: The local SCS office should be able to give you assistance in locating a rangeland drill. If there are not any rangeland drills available then the next best choice will be to locate a no-till drill that is designed to plant grass seed. I would recommend the type called Haybuster or Lilliston. Both of these drills have a good track record for planting grass seed. We will be aiming toward a late October/early November seeding date.

Required spot treatments: During the last visit I noticed a patch of spikeweed in area D2. This plant is an annual, dark green coloration, spikelike leaves, approximately 2 ft high, with yellow flowers. The patch is approx. 20 to 30 ft long in the northeast area of D2. These weeds should be mowed to prevent them from spreading seeds.

Seed bed preparation: Your staff should double check the availability of a sprinkler system and an adequate water source for irrigation in September. Your ability to irrigate in September is critical for the fall control of cheatgrass and the eventual success of the grass seeding. Since the window for these activities is narrow, it will be critical that we avoid any delays associated with resource availability.

Cc: W.C. Krueger
E. Starkey
J.Larson

Excerpts from Administrative History 1988, Whitman Mission National Historic Site, National Park Service, USDI, Pacific Northwest Region.

Page 83. Ever since 1950, when Robert Weldon first planted rye grass, the park's grassland has concerned administrators. Grassland management began anew then park administrators requested Dr. Gerald Wright of the University of Idaho's Cooperative Park Studies Unit to study the grazing conditions on the Park's south pasture. An agricultural use plan for this acreage was developed after consultation with the Forest Service, the Bureau of Land Management, the County Extension Office, and the Mission staff. A plan for revegetating the park's remaining acreage was developed in 1984 by Cathy Gilbert of the Regional Office and in 1985 by Dr. Jim Romo and Dr. William Krueger of the Cooperative Park Studies Unit at Oregon State University. Amdor explained their prescription in the 1985 Annual Report:

They divided the park into five areas, and provided revegetation prescriptions for each area. The first phase, involving the north and part of the west side of the park, proceeded smoothly in 1985. It involved the use of prescribed fire, herbicides, and livestock grazing to eliminate noxious weeds and prepare for revegetation in fall, 1986.

Unfortunately, the results were not as expected so preliminary ground preparations continued in 1986 with results anticipated in 1987. Thus, an idea that first began with a few clumps of rye grass under Robert Weldon's guidance, culminated in a project designed to revegetate the entire park with native growth, predominantly rye grass. This is a long-term management solution to a long-term maintenance problem.

Page 123, under Natural Resource Management:

An important result of this new awareness is the current revegetation project. In 1984, Landscape Architect Cathy Gilbert completed the "Landscape Study and Management Alternatives for Revegetation," which outlines specific steps for managing the park's natural resources and preserving the historic scene. The "Landscape Study" acknowledges the difficulty in reestablishing the native vegetation because of the greatly modified landscape, yet concurs

with the goal stated in the park's "Statement for Management": "To maintain as nearly as possible, the visual aspect of the historic period commemorated." Therefore, the "Landscape Study" divides the park into six separate land units recommending different revegetation options for each unit. As a follow-up study, Jim Romo and William Krueger of the Cooperative Park Studies Unit at Oregon State University completed the "Weed Control and Revegetation Alternatives for Whitman Mission National Historic Site" in 1985. This study subdivided Gilbert's six units into fifteen areas and prescribed specific revegetation instructions and timelines for each area, including prescribed burns, herbicides, and reseeding. However, park administrators were dissatisfied with the results so they turned, once again, to Oregon State University for advice. Superintendent Herrerra explained that their current consultant has a different theory about the best way to revegetate the park:

The agronomist from Oregon State University, Dr. Larry Larson, told us last week …that when [you disturb ground by burning, plowing, and spraying herbicides] and then attempt to reseed it and hope that …you don't lose that reseeding due to competition, he says, you could be worse off than when you started…you could have a bumper crop of weeds the next year.

Therefore, Dr. Larson's plan entails planting grass varieties that are least competitive with the native species, and then once these varieties are established, plant the desired native grasses. Superintendent Herrera is confident about Dr. Larson's plan and predicts the project will last for 5-8 years. Chief Interpreter Trick anticipates that, at the end of that time, probably 75 of the park's 95 acres will be revegetated. Trick considers revegetation both a cultural and natural resource project because native growth will improve not just the park's appearance but interpretation, too. Superintendent Herrera agrees that revegetation will have a dramatic effect on interpretation:

If visitors in years to come can come here and see some of the native tall grasses and other vegetation that was here 150 years ago, that you rarely see in this area any more, it would be quite an attraction…they will sense that there's something special about this place.

Thus, revegetation is a program that will contribute to increased awareness of both natural and cultural resources and will help ensure their care in the future.

Annual Report: Whitman Mission Revegetation Project. Larry Larson, Rangeland Resources Department, Oregon State University. 1988.

Introduction

The purpose of this report is to provide a written record of the revegetation project at Whitman Mission during the time period April 1987 through December 1988. Prior to 1987 the Park Service contracted with Oregon State University to develop a revegetation plan. However, several revegetation failures resulted when the plan was implemented without adjusting the plan to current site conditions. As a result the current contract was adjusted so that on-site consultation would occur during the implementation of revegetation projects.

The overall objective of the current contract is to return the vegetation in the park to a composition and appearance similar to the time period when the mission was active. The revegetation project is designed to occur in two phases. The first phase requires the stabilization of abandoned cropland with species (native and non-native) that are ecologically similar to indigenous species. Areas stabilized in phase one will not require herbicide treatments until phase two is begun. The second phase of the project places an emphasis on the establishment of native species on each of the revegetated areas after they have been stabilized.

The existing park vegetation is the result of two land uses. The mission was dominated by a variety of agricultural uses prior to its designation as a National Historical Site. Once the area was designated as a National Historical Site the emphasis on agricultural land use was phased out and historic preservation and public information became the dominant land use. This transition resulted in the creation of approximately 50 acres of abandoned farmland that was dominated by a variety of weed species in 1987.

1988

Letter from District Conservationist Larry Hooker, USDA Soil Conservation Service, to Superintendent Dave Herrera, Whitman Mission NHS.

In regard to your pond bank stabilization project, I understand you need some additional recommendations on plant materials adapted for the site.

As Mark Wasemiller and Ron Long no doubt mentioned, the problem of wave-action and bird traffic use makes it tough on most vegetation. There are several plant materials, however, that are adapted to the situation and can do the job if you get them established. These are (in my order of preference):

[1] Garrison meadow foxtail-Garrison is a vigorous sodder that can stand wet feet. In other words, it is tolerant to wet conditions and will grow right at and slightly into the waters edge. Once established it's a beautiful grass and looks much like timothy (in some regions, it is called German timothy). Garrison, with its light fluffy seed, is not the easiest grass in the world to seed. If drilled, it must be diluted with rice hulls. Seed at 10 lbs./acre Pure Live Seed.

[2] Sodar steambank wheatgrass--Sodar is also a vigorous sodder, but it is slower to establish. It is very drought tolerant. But where the pond banks get periodic sprinkler irrigation, this is not so important. Probably the best feature of Sodar is its lower growth characteristic. It is a low-maintenance grass and would obstruct the view of the pond less than either of the other grasses. When seeded, it should probably be planted with 1 to 1 ½ lbs/acre of perennial ryegrass (*Lolium perenne*) to provide a quick cover. Perennial ryegrass is a short-lived perennial and will soon die out leaving the Sodar to occupy the site. Seed the Sodar at 16 lbs/acre Pure Live Seed.

[3] Reed canarygrass—Another vigorous sod-former, this is one of the best known grasses for stream and pond-bank stabilization. It can, however, get very large in growth stature. Stands get very dense. It can be planted by seed or by "sprigging". Seed at 10 lbs/acre Pure Live Seed or plant on spring every 10-12 inches at 2-3 inches deep. Canarygrass is probably the easiest of the three grasses to establish, and is the least costly.

Information sheets enclosed for various species.

1989

Whitman Mission Revegetation Annual Report; 1989. Larry Larson, Rangeland Resources Department, Oregon State University. Received WHMI Dec. 20, 1989.

The objective of the Whitman Mission project is to reconstruct the vegetation at the mission to a composition and appearance similar to the time period when the mission was active. The use of mechanical and chemical tillage practices has been kept to a minimum in this project. However, vegetation establishment is a higher priority than the avoidance of short-term tillage practices. Consequently tillage techniques that improve the likelihood of revegetation success and have short-term environmental impact are used to establish vegetation.

The purpose of this report is to provide a written summary of the revegetation project at Whitman Mission during 1989. The revegetation project has been partitioned into two phases. Phase 1 of the project began in 1987 and has been focused on the control of weedy vegetation and the establishment of vegetation similar in appearance to the original native vegetation (see 1988 annual repot). Phase 2, the establishment of native vegetation, was begun in 1989 and will be a visible component of the park in 1990.

1990 Revegetation Effort

The revegetation effort in 1990 will emphasize the establishment of native vegetation. Phase 1 of the project should be completed in 1990 and the treated areas should not require any additional mechanical or chemical tillage practices until islands of native vegetation are created. The timetable for this to occur will be dependent upon the desires of the Park Service staff.

Phase 2 of the project will be the primary emphasis of the revegetation effort for the next several years. The basic pattern for the revegetation effort will be to establish a dominant native grass vegetation followed by the creation of islands of secondary native forb and shrub species.

This process requires research in two areas: [1] Weed Control- The island concept of secondary species establishment is built upon the realization that localized disturbances by gophers, badgers, grazing, et. Create openings for species colonization. These openings present natural opportunities for increasing native diversity. The question we must address is how to control weed encroachment while encouraging native species establishment. [2] Vegetation Management- Established grasslands must be maintained by management. This means that methods of maintaining vegetation vigor must be developed so that plant density will not decline and weed encroachment begin. In addition the method of management should facilitate the spread of desirable secondary species throughout the community.

A series of research studies is being designed so that results will be applicable to all of the parks included in the original contract.

1990

National Park Weed Study, Three Year Strategy, 1990. Cover letter from Larry Larson to Ed Starkey.

This proposal is based on observations at Whitman Mission, John Day Fossil Beds, Fort Spokane, and the Nez Perce Park. Excerpts from the study indicate that all four parks have serious problems with weed encroachment by diffuse knapweed (*Centaurea diffusa*), yellow starthistle (*Centaurea solstitialis*), Russion knapweed (*Centaurea repens*), and whitetop (*Cardaria draba*).

The purpose of this study is to determine weed seedling emergence and survivorship under varying osmotic, saline, and environmental regimes. Research results would be to interpret the potential for encroachment of the four previously mentioned species on different soil types and plant communities.

The proposal describes research studies for seed germination, seedling survivorship, seed viability as well as the methodology to conduct these studies.

Introduction: The encroachment of exotic weed species into natural and culturally historic lands of National Parks is a serious problem. Parks in the Pacific Northwest are addressing this problem by developing integrated pest management (IPM) programs. However, the success of these programs will be dependent upon the ability of the Park staff to identify: [1] Lands susceptible to weed encroachment, [2] Plant communities capable of competing

effectively against weed species, and [3] Plant communities that can be maintained with limited energy input, given existing and future management plans.

Ecosystems are dynamic natural systems that strive toward a balance among their biotic and abiotic components. Inherent to the normal functioning of an ecosystem are changes within and across ecosystem boundaries that are brought about by natural and man caused disturbances. These disturbances give rise to much of the diversity that is viewed in a landscape. A troubling aspect of ecosystem management is the ability of weeds to utilize disturbance and modify vegetation diversity. The introduction of alien weed species that have wide ecologic amplitude, can result in wholesale species replacement following natural disturbance as well as the disruption, if not stagnation, of successional processes. For example, consider the impact that cheatgrass (*Bromus tectorum*) and medusahead wildrye (*Taeniatherum asperum*) have had on the productivity and vegetation diversity of western rangelands, and then consider the potential impact of perennial knapweed species (*Centaurea* spp.), leafy spurge (*Euphorbia esula*), whitetop (*Cardaria* spp.) and other exotic weed species on these same rangelands.

The park staff at Whitman Mission NHS, John Day Fossil Beds NM, Fort Spokane NHS, and Nez Perce NHS are all faced with serious weed encroachment problems by diffuse knapweed (*Centaurea diffusa*), yellow starthistle (*C. solstitialis*), Russian knapweed (*C. repens*), and whitetop (*Cardaria draba*). Several studies have been conducted by researchers that relate directly to IPM programs for these weed species. Research conducted by Talbott (1987) provides information on the distribution and ecologic amplitude of knapweed species in eastern Washington. Larson and McInnis (1989) have conducted two studies indicating that diffuse knapweed and yellow starthistle can be controlled during grass stand establishment and that establishment of specific grass species will minimize, if not control reinvasion by these species. Smergut and Larson (unpublished, 1989) have determined that whitetop seedling survival is relatively uncommon in the sagebrush ecosystem, being dependent upon moist spring environments. Furthermore, soil disturbance and vegetative reproduction appear to be the dominant method of whitetop maintenance and spread in this ecosystem.

The techniques and knowledge derived from this research have been applied successfully to areas at the Whitman Mission and John Day Fossil Beds. However, before a comprehensive IPM program can be developed, land areas that are most susceptible to weed encroachment must be identified so that limited resources can be focused on problem areas. Furthermore, each of these parks has expressed an interest in increasing native diversity beyond the establishment of two or three dominant species. This will require continual community disturbances (natural and man caused) and the introduction of secondary native species. What will be the competitive outcome between native species and exotic weed on localized areas of community disturbance? To answer these and similar questions about weed encroachment we need to understand how specific environmental conditions limit the spread of these weeds (i.e.; moisture, salinity, and climate exposure) and how land management can be tailored to encourage the establishment of native species over exotic weeds.

We believe that answers to a number of these problems can be approximated if not determined by studying the component parts of plant establishment. This report contains two figures which illustrate the life cycle of annual and perennial plants which include a number of growth events (germination, growth, establishment, etc.) that must survive environmental and biotic thresholds of stress for the plant to survive within a community. We have prepared three related proposals that focus on the requirements of successful weed establishment. A summary

entitled “NPS Application” has been provided at the end of each proposal to illustrate the application of these research results to National Park weed problems.

PROPOSAL

The purpose of this study is to determine weed seeding emergence and survivorship under varying osmotic, saline, and environmental regimes. Research results would be used to interpret the potential for the encroachment of diffuse knapweed, yellow starthistle, Russian knapweed, and whitetop on different soil types and plant communities.

Seed Germination

Objective: To determine the influence of osmotic and saline stress on seedling emergence: [1] How is germination and initial root elongation influenced by osmotic potential? [2] How is germination and initial root elongation influenced by saline concentration?

Weed seeds would be collected just prior to seed drop to insure seed viability. Seed would be cleaned by separating the seeds from the seed heads in a blender and using a combination of sieves and air pressure to separate seeds from chaff. A germination test would be performed on each seed lot to determine viability.

Seed germination and root elongation tests will be performed on all four weed species. The tests will be conducted in environmental chambers set at 20C (dark). Lots of 50 seeds will be placed in Petri dishes containing filter paper saturated with treatment solutions and sealed with petroleum jelly. The treatment solutions will be replaced at 4-day intervals. Seeds will be inspected at 2-day intervals during the 16-day germination period. Germinated seeds will be counted and removed in the germination tests on each inspection date and seed counts will be converted to percent germination for analysis. The root elongation study will be started by germinating a seed reservoir. Then day-old germinated seeds will be removed, measured, and placed in replication dishes to monitor root growth for 8 days under treatment conditions.

Osmotic stress experiments will be conducted by placing seeds under different osmotic potentials. The osmotic stress will be provided by using Poly Ethylene Glycol (PEG) and water mixtures at 1, 5, 10, and 15 bars of osmotic tension. The osmotic potential of each solution will be verified using a thermal couple psychrometer.

Saline stress experiments will be conducted by placing seeds under different regimes of saline concentration. The saline solution will be obtained by mixing CaCl2 and NaCl salts to achieve electrical conductivities of 0, 4, 8, and 12 (dS/m). Each salinity level will be mixed to achieve a sodium adsorption ratio of less than 2. Solutions will be verified by measuring electrical conductivity.

Each experiment will be analyzed using ANOVA and response surface techniques. Experimental treatments will be equally spaced and replicated 4 times.

Seedling Survivorship

Objective: To determine the influence of matric stress and salt concentration on seedling survivorship: [1] How is seedling stress (seedling height, biomass above and below ground), leaf characteristics, and the occurrence of wilting influenced by changes in soil matric potential? [2] How is seedling stress (seedling height, biomass above and below ground), leaf characteristics and the occurrence of wilting influenced by saline concentrations?

Matric stress tests will be conducted in an environmental chamber and will consist of growing seedlings under different matric potentials. The chamber will be set for a 16-hr dark period as 15-20C followed by an 8-hr light period at 20-25C. Pots containing soil (greenhouse potting mixture) will be brought to specific matric potentials (range: 0-1/0 bars) to initiate the

study. A tensiometer will be placed in each pot to monitor matric potential throughout the study. Weed seeds or seedlings will be planted in the pots and allowed to grow. The weeds will be thinned to 5 seedlings per pot. Plant stress will be monitored every 2 days for 30 day time period to determine seedling number, max. leaf length, leaf number, plant height, and wilting. At the end of the trial, the seedlings will be excavated, and above and below ground biomass determined. The trial will be replicated 4 times.

The environmental chamber will also be used to measure seedling stress in saline solution. Seedlings will be placed in beakers containing a greenhouse potting mixture brought to specific saline concentrations (0, 4, 8, and 12 dS/m) by additions of CaCl and NaCl. The experiment will be conducted at the chamber setting previously stated. Seedlings will be monitored on 2 day intervals for 30 days to determine seedling number, maximum leaf length, leaf number, plant height, and wilting. At the end of the trial the seedlings will be excavated and the above and below ground biomass determined. The trial will be replicated 4 times.

Seed Viability

Objective: To determine the influence of winter conditions on weed seed viability: [1] How is seed viability influenced by climatic exposure, planting depth, and topographic position during the winter?, [2] How is field germination influenced by exposure, planting depth, exposure time, and topographic position between October and May?

Cleaned seeds will be measured into lots of 50 seeds and sealed in nylon seed packets. The packets will be placed in the field in the fall. Experimental treatments will consist of combinations of planting depth, exposure time, and topographic position with each experiment replicated 4 times.

Seed packets will be retrieved at six week intervals beginning on 11/15 and ending on 5/1. Each packet will be opened and the number of field germinated seed will be counted and discarded. The remaining seeds will be placed in sealed Petri dishes containing saturated (distilled water) filter paper. The Petri dishes will be placed in the environmental chamber set at 20C (dark). Seeds will be inspected at 2-day intervals during a 16-day germination period. Germinated seeds will be counted and removed on each inspection date. Seed counts (field and Petri dish) will be converted to percent germination for analysis. Each treatment will be replicated 4 times.

NPS application

Proposal One concentrates research on the environmental factors that influence seed germination and seedling survival. The purpose of each experiment is to establish upper and lower limits for weed seed germination and/or seedling survival. Once these limits are known, they can be combined with soil surveys (SCS) and modest field inventories to map individual parks according to the threat of weed encroachment. This information would allow individual parks to target resource dollars more effectively and improve estimates on weed control costs.

Proposal (Vegetation Interaction)

The purpose of this study is to determine weed survival in natural and vegetated plant communities. Research results would be used to interpret community resistance to potential weed encroachment and the role of physical soil disturbance in the process of weed encroachment.

Environmental Chamber Studies

Objective: To determine the ability of weed and grass seedlings, grown in combination, to survive in a controlled environment. [1] How is weed seedling stress (seedling height, biomass (above and below ground), leaf characteristics, and the occurrence of wilting)

influenced by distance to a grass seedling? [2] How is grass seedling stress (seedling height, biomass (above and below ground), leaf characteristics, and the occurrence of wilting) influenced by distance to a weed seedling?

A systematic design (Nelder Fan Design) would be used to measure the stress exhibited by weed and grass seedlings grown (monocultures and combined) at varying distances. Multiple seeds would be planted at each location where a seedling is desired and then thinned to achieve the desired pattern.

The seeds will be planted in flats containing soil (greenhouse potting mixture) and will be moistened to specific matric potentials (range: 0-1.0 bars) to initiate the study. A tensiometer will be placed in each flat to monitor matric potential throughout the study. The environmental chamber will be set for a 16-hour dark period at 15-20C followed by an 8-hr light period at 20-25C. Plant stress will be monitored every 2 days for a 30-day time period to determine seedling number, max. leaf length, leaf number, plant height, and wilting. At the end of the trial the seedlings will be excavated and above and below ground biomass determined. Each trail will be replicated 4 times.

Field Studies

Objective: To evaluate the ability of weeds to become established in plant communities. [1] Does soil disturbance influence weed survival in established plant communities? [2] Does plant spacing influence weed survival in established communities? [3] Does associated plant species influence weed survival?

Native plant communities that represent healthy good condition rangeland will be selected for weed seed introduction. A rectangular grid will be established for each community. Each grid will contain 36 points of seed introduction (4 replications, 3 types of disturbance, and 3 sizes of disturbance). The type of disturbance would be undisturbed, disturbed in-place, and soil churning. Soil churning would eliminate existing vegetation and invert the upper 6-8 inches of soil. Disturbance in-place would loosen the soil to a 6-8 inch depth but would not invert the soil of eliminate existing vegetation. The size of the disturbance treatments would be .1m square, .5 m square, and 1 m. square. Viable weed seeds (50) would be introduced into the center of each treatment area in the fall and monitored the following growing season. The study would be repeated for two growing seasons.

A second field study would be conducted in a nursery setting at the Eastern Oregon Agricultural Research Center in Union, Oregon. The nursery would be comprised of native and introduced grass varieties planted at varying drill row widths. This setting would allow us to determine drill row widths and variety combinations that would favor weed control. The basic experimental design described above (4 replications, 3 types of disturbance, and 3 sizes of disturbance) would be used in the nursery trials to study the influence of variety, drill row width, and disturbance in weed encroachment.

Correlated moisture data would be provided in each study by establishing tensiometers in a set of control treatments established in the center of each grid. The tensiometers would be monitored at two day intervals to establish an example of the moisture stress faced by the weed seedling.

PROPOSAL (Animal Interaction)

The purpose of this proposal is to determine if grazing impacts can be utilized as a management tool on National Park lands to control weed species and establish and maintain diverse biological communities. The objective of this proposal is: [1] To define the impact of

ruminant ingestions on weed seed viability; and [2] To develop grazing management strategies that can facilitate weed control and ecological stability.

Ruminant Ingestion And Fecal Deposition

The purpose of this study is to determine if grazing animals can be used as a tool to disperse seed and enhance the likelihood of seedling establishment. This study will initially be applied to weed species identified on page 2 of this document. However, the concepts and methodologies described should also be applied to native species to determine if ruminants can be used to enhance native seed germination and subsequent establishment.

Objective 1: To determine if the ingestion of viable seeds by ruminant animals influences seed viability. [1] Is seed germination influenced by passage through a bovine digestive tract?, [2] What is the mean passage rate of seeds through digestive tracts of cattle fed a high-fiber diet as would be typical during fall and winter months?

Feeding trials would be conducted at Eastern Oregon Research Center in Union, Oregon. Four steers (replications) will be housed in separate pens on concrete flooring during the feeding trials. The steers will be offered a hay (grass/alfalfa mix) diet for a 7-10 day period prior to feeding trials, and will be maintained on this diet throughout the trials. In the morning of day 1 of the feeding trial, a predetermined number of seeds (1000 size dependent) will be administered to each animal by placing seeds in #00 gelatin pharmaceutical capsules and force feeding. A sample of 50 seeds/steer will be removed from each capsule seed lot prior to force feeding and saved later germination trials. During the morning and evening (12 hour intervals) of each of the following 7 successive days, samples of equal volume from each defecation will be collected from the floor of each pen. Samples will be washed and decanted in water to remove seeds (washed seed). The number of seeds within each sample will be recorded each day. Subsamples of equal numbers of washed seeds removed from each defecation will be saved for germination trials.

The germination trials will be conducted on non-ingested and washed seed in environmental chambers set at 20C (dark). Lots of 50 seeds will be placed in Petri dishes containing filter paper saturated with distilled water and sealed with petroleum jelly. Seeds will be inspected at 2-day intervals during a 16-day germination period. Germinated seeds will be counted and removed in the germination tests on each inspection date and seed counts will be converted to percent germination for analysis.

Daily counts of seeds collected from the pen samples will be used to estimate the mean passage rate. Inspection of the seeds will be used to determine if the seeds are germinating in the digestive tract are being digested. If seed digestion is occurring then the process of digestion will be studied using two strategies:

[1] In vitro digestibility: lots of 100 non-ingested seeds will be digested for varying lengths of time (24-hour intervals for 14 days), removed and germinated. Comparison of percent germination will be made across digestion time. [2] In vivo using nylon bag: lots of 100 non-ingested seeds will be sewn into nylon bags, suspended in a ruminally fistulated steer, and allowed to digest from 1-14 days. Each day, one lot will be withdrawn and germinated.

Objective Two: To determine if the injection and subsequent defecation of seeds by ruminants enhances seedling emergence and survival. [1] Is seedling emergence and survival influenced by ingestion and subsequent defecation?, [2] Is seedling emergence and survival influenced by soil disturbance?

Two groups of steers will be housed on concrete flooring. One group will be fed a hay diet only. The second group will be fed the same hay diet and will be force fed gelatin

pharmaceutical capsules containing seed. Manure from each group of steers will be collected. Lots of 50 washed seed will be mixed into the manure from the hay-only steers and formed into "pats" of equivalent volume by combining in a bucket.

The mixed "pats" will be placed in selected communities in late fall. Thirty-two microplots (1 x 1 m) will be identified in the community. A random numbers table will be used to assign the microplots to one of two groups: [1] sixteen "disturbed" microplots will be churned using and shovel to kill exiting vegetation and create a clearing; [2] sixteen "undisturbed" microplots will be left intact. Each microplot will receive one "pat" and one lot (50 non-ingested) of seed placed adjacent to the "pat". Each microplot will be examined through the year to monitor seedling emergence and survival.

Biological Control Using Large Herbivores

Herbicides are, and most likely will remain, a dominant tool in weed control programs. However the rate and periodicity of herbicide application is rightfully being questioned in light of environmental concerns over herbicide toxicity and residual characteristics. We believe that research is needed to improve the effectiveness of herbicides, so that similar levels of weed control can be achieved with less actual herbicide use.

Two problems commonly associated with herbicide application are [1] Vegetation structures (i.e., plant height, density, and canopy cover) that prevent adequate penetration of the chemical beyond the upper most leaves, thereby reducing weed mortality or requiring greater amounts of herbicide; and [2] Variable phenology of individual plants which result in fewer plants being susceptible to the herbicide.

Objective: To evaluate the response of weed species to herbicide application, using selective grazing to precondition weed phenology.

[1] Does properly timed grazing reduce weed vigor and reproductive efforts (e.g. seed production and viability) of weed species?, [2] Does selective grazing of weed species followed by herbicide application reduce the amount of herbicide required to control weeds?, [3] Does selective grazing of weed species result in regrowth that is less tall and more uniform in phenology thereby enhancing its susceptibility to herbicide treatment?

Grazing trials would be conducted on weed infestations to evaluate the effectiveness of selective grazing in an integrated pest management program. Each experiment would incorporate four treatments: [1] grazing alone, [2] herbicide treatment alone, [3] initial grazing followed by herbicide application, and [4] control. Each treatment would be replicated 3 times and would be 0.5 acre in size. The timing and intensity (stocking rate) of the grazing would be designed to achieve optimum growth characteristics for herbicide application.

Response measurements will include bi-weekly soil temperature and gravimetric soil moisture (s replications each plot at depths 1-8 inches and 8-16 inches): weekly phenology (100 marked plants categorized numerically by phonological stage); vegetative and reproductive stem density; seed production per stem; seed production per square meter; % seed germination; % utilization of the weed species and associated vegetation.

NPS Application

Proposal Three focuses on the interaction between large herbivores and weed populations. It is extremely important to find out whether weed seeds are passing through ruminant digestive tracts in a viable state and if fecal material aids a weed in the process of seedling establishment. If this is true then ruminants may also serve as a tool to disperse seeds of native plant species to improve plant diversity. In the matter of herbicide use ruminants may provide a means of preconditioning weedy vegetation so that less herbicide is required to achieve

the same level of weed control. Initial studies on whitetop indicate that simulated grazing (clipping) reduces plant vigor, height, density and increased uniformity in phonological development among individual plants. Applications of herbicide on these plots resulted in what appears to be a more effective control of whitetop infestation (1st year results).

Annual Report 1990, Whitman Mission Revegetation Project. Larry Larson, Rangeland Resources Department, Oregon State University.

The objective of this report will be to describe the revegetation program at Whitman Mission during the 1990 calendar year. This report details activities (completed and planned) relating to plant community stabilization, weed control, and native plant establishment.

Phase 1: Stabilization and Weed Control

Tall wheatgrass communities were established at the beginning of the Whitman Mission project (1987) to control weeds and begin the process of transforming the landscape of the park. Each of these seedings annually produce 2000-3000 lbs/A of grass biomass which has been accumulating on site. The initial accumulation of litter benefits the soil and aides the control of many weed species. However, excessive grass litter accumulation can also impede grass growth and adversely impact grass vigor. The oldest grass stands at the mission showed signs of declining biomass and vigor in 1990. In addition, these same grass stands showed an increase in litter tolerant weeds.

A vegetation maintenance program was designed and implemented on the oldest grass stands at the mission in the fall of 1990. The objective of this program is to stimulate grass vigor, reverse community trends that favor weed encroachment, and maintain viable units of wildlife habitat on the park. These objectives will be achieved through a series of controlled burns (3 year rotation) in tall wheatgrass, basin wildrye, and reed canarygrass communities. Midgrass communities such as bluebunch wheatgrass and big bluegrass will be monitored to determine when the litter accumulation in these communities warrant the establishment of a burn program. I anticipate a 5 year rotation program for these communities depending on their annual rates of growth and litter accumulations.

Phase 2: Native Community Establishment

The native plantings (miscellaneous area: 1990) located between the maintenance building and the visitor center successfully completed their first year of growth in 1990. The grass seeding developed into a one year old native grass stand, native shrubs were successfully established in clumps within the developing grass stand, and native forb gardens generated a sufficient number of forbs to warrant the establishment of a transplant program in 1991.

Letter from Larry Larson to Terry Darbey WHMI dated August 13, 1990. Subject Whitman Mission Vegetation Maintenance Program (3 year).

Phase 3: Tall wheatgrass seedings were established at the Whitman Mission beginning in 1988. Each seeding annually produces 2000-3000 lbs/A of grass biomass. The texture and volume of this biomass exceeds the decomposition rate and is resulting in an accumulation of grass straw at the ground surface. In general, the accumulation of litter is desirable since it modifies the site, improving soil structure and nutrient relationships from the grass stand. However, once the accumulation exceeds the rate of decomposition it begins to reduce the growth of the grass stand by limiting nutrient availability and light conditions at the soil surface. The tolerance limits of tall wheatgrass to litter accumulation was reached in the oldest grass

stands this summer. Consequently, the oldest grass stands are beginning to decline in grass productivity and are once again susceptible to encroachment by weed species.

Establishment of a vegetation maintenance program should begin this fall to reverse grass stand decline and improve vigor. The objective of the program will be to remove excess litter accumulation from the grass stands once it begins to exceed the tolerance limit of the dominant grass. Tall wheatgrass, basin wildrye and reed canarygrass appear to reach their tolerance limit after 3 years of litter accumulation. Midgrasses such as bluebunch wheatgrass and Sherman big bluegrass may not reach their limit for 5 years or longer depending on their rates of growth and litter decomposition. The easiest method of litter management will be to use controlled burns. The objectives of the burn program will be to : [1] stimulate grass productivity, [2] reverse trends that favor weed encroachment, and [3] maintain viable wildlife habitat during the management program. To achieve these objectives, I am proposing a 3-year rotation for controlled burns in tall wheatgrass, basin wildrye, and reed canarygrass areas. Figure 1 provides a map of the proposed fall burning schedule that rotates burns across these grass stands. The program will need to be monitored annually to determine if the desired effect is being achieved and when a control burn program should be implemented on midgrass areas.

Weed control: I believe that you can safely assume that you will have 2-3 acres of weed control problems that will need to be addressed annually. These area represent eye-sores for the most part and are typically in areas where initial seeding attempts were not successful or were not logistically possible.

This text is from a hard-backed folder labeled “Revegetation Project, and includes a page of introduction that is from 1989, as well as progress reports from up to 1990. There is no cover page or author, but notes are detailed, and included here. This folder also contains numerous photos of the revegetation program and could be part of the monitoring record.

Introduction

The purpose of this report is to provide a written record of the revegetation project at Whitman Mission during the time period April 1987 through December 1988. Prior to 1987 the Park Service contracted with Oregon State University to develop a revegetation plan. However several revegetation failures resulted when the plan was implemented without adjusting the plan to current site conditions. As a result the current contract was adjusted so that on-site consultation would occur during the implementation of revegetation projects.

The overall objective of the current contract is to return the vegetation in the park to a composition and appearance similar to the time period when the mission was active. The revegetation project is designed to occur in two phases. The first phase requires the stabilization of abandoned cropland with species (native and non-native) that are ecologically similar to indigenous species. Areas stabilized in phase one will not require herbicide treatments until phase two is begun. The second phase of the project places an emphasis on the establishment of native species on each of the revegetated areas after they have been stabilized.

The existing park vegetation is the result of two land uses. The mission was dominated by a variety of agricultural land uses prior to its designation as a National Historic Site. Once the area was designated as a National Historic Site the emphasis on agricultural land use was phased out and historic preservation and public information became the dominant land use. This

transition resulted in the creation of approximately 50 acres of abandoned farmland which were dominated by a variety of weed species in 1987.

(The remaining text of this report is contained under the Areas B, C, D2 and D3.)

Excerpts from final report for Phases I through IV of [1] Fire ecology research and riparian restoration work conducted at John Day Fossil Beds National Monument, and [2] Vegetation rehabilitation work conducted at John Day Fossil Beds National Monument and Whitman Mission National Historic Site. Received WHMI Feb. 5, 1993. Only excerpts applicable to WHMI recorded here.

Revegetation Summary, Whitman Mission National Historic Site. Revegetation projects began at Whitman Mission in 1987. Projects were designed to occur in 3 phases; Phase 1 stabilized areas within the park that were occupied with exotic weed species using mixtures of native and exotic grasses; Phase 2 emphasized the establishment of native communities in areas frequented by park visitors; and Phase 3 involved the development of a vegetation management program for the park. All 3 phases are currently occurring on the park.

Phase 1: Phase 1 management was applied to approximately 60 acres of the park between 1987 and 1989. At the time of project initiation, these areas were dominated by a host of weed species including yellow starthistle, diffuse knapweed, and spikeweed. Weed control was initiated with a mixture of herbicide (Roundup or 2,4-D + Banvel) and tillage (roto-till) treatments tailored to match the specific needs of the site. The best seeding results were achieved by using a John Deere Power-Seeder with plantings occurring in either the late fall or early spring. Fall seedings were best suited for seedbeds that were relatively clean from weed seed. Spring seeding were most effective when winter annual weed seeds were a likely contaminate of the seedbed and a pre-planting treatment of Roundup was used to minimize seedling competition. Most Phase 1 sites were in the flood plain and contained remnants of former river channels. The original vegetation in the flood plain is believed to have been basin wildrye with the river channels dominated by reeds, rush, and sedge. Flood plains were seeded with a mixture of tall wheatgrass, basin wildrye, and bluebunch wheatgrass. Tall wheatgrass, an exotic, was selected as a major component of the seed mix because it provides a similar appearance to the native basin wildrye and has greater seedling vigor in the early stages of stand establishment. All of these seedings were successful and give the appearance of native stands of basin wildrye. The remnant river channels were broadcast seeded to canary reedgrass and Sherman big bluegrass. The landscape mosaic of this area is visibly delineated into remnant river channels and floodplain by contrasting texture and color differences in the vegetation.

Phase 2: Native revegetation efforts are being conducted on approximately 30 acres of the park. In general, native grass seedlings tend to be less competitive than exotic grass species. Consequently, this phase of the project has a higher risk of seeding failure. Approximately 20 acres of the park have been established as native grass stands (basin wildrye, bluebunch wheatgrass, and Sherman big bluegrass). Native forbs and shrubs (8 species) are also being established along the main pathways of the park.

In most cases, the established native communities are proving susceptible to low levels of weed invasion and it is doubtful that any of the re-established native plant communities will

become weed-free through competition alone. In addition, several of the established native seedings contain significant populations of weed species that will require control measures to reduce them to an acceptable level. Approximately 7 acres of the land selected for native community establishment have suffered a seeding failure due to drought or excessive weed competition.

Phase 3: A vegetation management program was initiated in 1990. The objective of the program is to control the build-up of plant residue. Excessive residue accumulation results in grass stand stagnation, loss of grass density and an increase in weed encroachment.

The management program controls residue accumulation through the use of controlled burns. The taller grass stands of basin wildrye and tall wheatgrass yield 2000-3000 lbs (dry matter)/A/year and have been placed on a 3 yr controlled burn cycle. Bluebunch wheatgrass stands yield 1000-2000 lbs/A/Year and are on an 8-10 year burn cycle. In situations where scheduled burns cannot be achieved, flail mowing is being used to break down the residue. The latter method reduces the rate of grass stand stagnation, but is not as effective as a controlled burn and should not be viewed as a substitute for periodic burns.

B. WEED RESEARCH SUMMARY: The remaining 13 pages of this document reviewed the detailed research methods used to assess seed germination, and radicle elongation of several weed species. Seed viability tests were also part of this report, with tests being conducted at both Walla Walla, and La Grande, OR.

This information is not included as part of this excerpt, and there are no maps with this report.

January 30, 1995, Doan Creek Restoration Plan, Whitman Mission National Historical Site, Interfluve, Inc.

This report **i**ncludes both a North Channel, and South Channel. The recommendations break the channels into Vegetation Zone I for the North Channel, and Vegetation Zones I and II, Restoration Zones I and II for the South Channel.

Proposed actions in Vegetation Zone I is to burn stream banks back to about 10 feet in late fall to early spring. Trees and shrubs as follows should be planted after burning:

Shrubs
Nootka Rose
Golden current
Red-osier dogwood
Syringa
Blue elderberry
Trees
Western water birch
Black cottonwood
Willow
Black hawthorne
Aspen

Proposed actions in Vegetative Zone II is to lightly burn stream banks back about 10 feet in the late fall and early spring, and to plant shrubs from the following list:

Nootka rose
Golden current
Red-osier dogwood
Syringa
Blue elderberry

In Restoration Zone I, there are two options listed. Option I is a 36 inch diameter culvert for the entire 1,230 foot length of the revegetation zone. Back-filling the ditch and revegetating the segment with the following species:

Grasses

Bluebunch wheatgrass
Idaho fescue
Inland saltgrass
Great basin wildrye

Option II is to excavate along both sides of the existing ditch, resloping the banks, and reseeding with the following species:

Grasses

Blue bunch wheatgrass
Idaho fescue
Inland saltgrass
Great basin wildrye

Shrubs

Nootka rose
Golden current
Red-osier dogwood
Syringa
Blue elderberry

Trees

Western water birch
Black cottonwood
Willow
Black Hawthorne
Aspen

In Restoration Zone II, the following actions are proposed: The northern ditch bank from waters edge back about 10 feet should be lightly burned in the late fall to early spring, and hydroseeded to the following mixture:

Grasses
Hard Fescue
Sheep fescue

This study describes in detail seeding and planting specifications, timeframes, and monitoring requirements.

February 1996 Doan Creek Restoration Plan and Environmental Assessment, Whitman Mission National Historic Site, Roger Trick.

Alternative C is the proposed Alternative-Implement Doan Creek Restoration Plan. Included in the proposed alternative is the objective of reducing the maintenance required by stabilizing the banks with native vegetation and removing the exotic pest plants. Some zones do not need intensive channel alterations to conserve irrigation flow or stabilize eroding channel banks. They require more trees and shrubs to provide shade and stability. Establishment of a tree and shrub component is a means of increasing vegetative diversity, promoting competition with canary grass and other weedy species, and reducing the need for mowing, chemical treatments, and other maintenance activities.

Doan Creek was divided into **6 zones**. Excerpts from the Proposed Actions in these zones are as follows**: Zone 1**-includes installation of a buried culvert for 1230 feet of this zone, and have native grasses planted above the buried pipe to compete with canary grass.; **Zone 2**-maintain the current stature of the vegetation along this zone by replacing trees and shrubs when they die. Planting more shrubs along the ditch where this component is missing will create more competition for exotic species and provide additional erosion protection; **Zone 3a**-This zone along ditch would require burning and/or herbicide treatment initially. This would occur in the late fall or late winter, with seeding of native grasses following almost immediately; **Zone 3b**-Isolated locust trees in groups of two or three trees could be planted along this zone, with most of them planted on the south side of the ditch. The north side of the ditch supports canary grass, wild iris, and other exotic plants. Burning or herbicide treatments would allow for re-establishment of native grasses such as Idaho fescue, streambank wheatgrass, and hard fescue. Use of native grasses on the north bank should significantly reduce erosion; **Zone 4-**Most of Zone 4 would benefit from additional planting of native grasses such as those used in Zone 3, e.g., fescue, wheatgrasses and wildrye; **Zone 5**- There is a 5 acre area with canary grass, poison hemlock and other exotic plants which may meet the criteria of a wetland. The long term goal in this zone is to replace exotic plants to native ones; **Zone 6**-No management action is contemplated for Zone 6.

Excerpts from Exotic Pest Plant Inventory, Mapping, and Priorities for Control in Parks in the Pacific Northwest. A Draft Report. Monello, Ryan J., and Wright, R. Gerald. Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID.

(Page 9) Six noxious weeds were delimited on the Whitman Mission National Historic Site: field bindweed, jointed goatgrass (*Aegilops cylindrical*), poison hemlock, yellow starthistle, Canada thistle, and scotch thistle. (Figure 5, Table 1). Most abundant were the latter three, with large, dense portions of scotch thistle exiting primarily in the southern portion of the historic site. Commonly though, yellow starthistle, Canada thistle and scotch thistle co-occurred bordering each other in the form of large patches throughout the monument, but primarily in the center

portion surrounded by paved walking trails. Field bindweed, jointed goatgrass, and poison hemlock constituted a substantial portion of infestation as well, but this was centered in the southern portions.

Discussion/Management Recommendations

Common Noxious Weed Species

Options for the control and management of noxious weeds are limited to three basic categories: [i] physical eradication by hand (pulling, digging or tilling the weeds and roots); [ii] the application of herbicides; and [iii] the release of a biological control, often an invertebrate species or fungi which will decimate the plants (William et.al. 1996). Except for a few cases, biological controls are usually unreliable because of poor synchronization between insect and weed life cycles (Youssef and Evans 1994). Thus it is common for introduced invertebrates to fail to become established within an area, or even state (William et al 1996). The majority of appropriate control, eradication and suppression methods discussed here, exist in the form of herbicide application, reapplication, and often additional planting of competitive native species (Table 2). However, in some cases certain restrictions apply (Table 2).

There is no doubt the noxious weeds have proven effective in invading formerly disturbed areas. Two of the most successful species are Canada and scotch thistle. Canada thistle, which occurred on seven of the park sites surveyed, has displayed a particular affinity to colonize agricultural drainages and Stillwater areas in most all park lands. This is not surprising, for it has consistently been referred to as one of the most troublesome weeds in Canada and the northern half of the United States (Morrison 1980), causing major crop losses in alfalfa, cereal, and canola crops (Moyer et al 1991, Donald and Khan 1995). Difficulty in controlling this perennial weed is due to its deep roots (Nadeau and Born 1989) and ability to reproduce vegetatively as well as from seeds (Ang et al 1994). In addition, causing a breakage in the roots by plowing or physical removal, will only serve to increase the number of plants (Whitson et al 1992, Lalonde and Roitberg 1994). Therefore, the route recommended for the control of Canadian thistle is by way of the biological agent *Rhinocyllus conicus* or a chemical treatment (William et. Al. 1996) (Table 2). However, control measures must be timely and used for at least two to three successive years (Reece and Wilson 1983). It is also suggested that a multiple stress strategy be employed, such as introduced competition through planting and introduced biological control agents or selective herbicides (Ang 1994). Lee (1952) stated “no single treatment, regardless of practice, can be relied upon to produce complete kill (of Canada thistle).” This idea has been supported by Strand (1982) and Donald (1992).

The disadvantage of chemical treatment is that since the majority of Canada thistle on National Park Service lands is located in or near drainage areas, and chemical contamination of the water could result. However, a variety of selective herbicides are available for selective control (Donald 1993), and can be applied prior to or in some cases after the budding stage (Table 2). Several sequences to spraying have also been recommended so as to reduce biomass to a greater extent (Donald 1992, Darwent et. Al. 1994). Spraying after spring rains and during dry periods would probably minimize contaminants.

(Portions of this report not pertaining to WHMI have been omitted)

Scotch thistle, often located adjacent to or within Canada thistle establishments, presents quite a different scenario. Plants are usually not as numerous, with exception of the WHMI site, and can be effectively controlled by digging up or applying herbicides to growing rosettes in the spring (Table 2). When possible, a combination of both strategies is probably most effective. No biological control has proven effective for this weed.

Yellow starthistle, though not occurring on as many sites, has proven quite successful in taking over large portions of former perennial grasslands (Sheley and Larson 1994a), sometimes occupying canyonlands at a rate of 80 percent a year (Callihan and Miller 1994). Various biological controls have been suggested, with more than six monophagous endophages proven to be effective (Clement 1990). Turner et.al. (1996) recently found that a seed head fly (*Chaetorellia australis*) resulted in a 95.4 percent reduction in seeds per infested capitulum. Effective control also exists by way of herbicide application in conjunction with the planting of perennials (Table 2). However, these selective herbicides must be applied prior to flowering and when the vegetation is wet (William et al. 1996).

However, until the eradication of yellow starthistle is carried out, burned areas would probably function exclusively to open up further habitat for yellow starthistle achenes (seeds) beneath the soil, regardless of depth (Callihan 1993). In addition, Sheley and Larson (1994b) note the ability of yellow starthistle roots to colonize deeper soils than i.e., downy brome, thus furthering their protection in the case of burning.

Field bindweed was present at or near five sites (Table 1). Normally, it is not considered strongly competitive, but extensive roots and rhizomes can compete for moisture and nutrients within the soil (Wises and Phillips 1976-5). Its ability to propogate by sexual and clonal means promotes its persistence (MacDonald et al. 1993). Early spring and fall application of herbicides is an effective removal method; however, tillage for three consecutive years also provides for eradication (Table 2). Due to its limited range within park lands, tillage or physical removal is therefore preferred. Additional Noxious Weeds

Weeds in this section are typically reduced in number, competitive ability (relative to the inland northwest park sites), or only at one or two park sites. Poison hemlock, jointed goatgrass, and jJohnsongrass are all species limited in their occurrence. The former is located on two park sites, while the latter two are located on only one park site. Eradication by glyphosate Roundup is suggested here due to their limited range (Table 2).

Table 1: Excerpts

National Park Site/Species	Extent/Location
Whitman Mission	
Bindweed, field	common/SE border
Goatgrass, jointed	rare/SE corner
Hemlock, poison	widespread
Starthistle, yellow	widespread
Thistle, Canada	widespread
Thistle, Scotch	widespread

Thistle, bull widespread

Table 2: Excerpts Eradication and control methods

Field bindweed: Banvel or Banvel+ 2,4-D bud/leaf gall mite
jointed goatgrass: Roundup or Oust, No biocontrol identified
poison hemlock: Roundup, Glean; defoliating moth
Yellow starthistle: 2,4-D; Seed head weevil
Canada Thistle; Amitrole, Amitrol-T, Amino Triazole 90, Weedazol, Cytrol, Escort; crown/root weevil, seed head weevil, or stem gall fly.
Scotch thistle: 2,4-D, Banvel, Telar, Escort: No biocontrol identified

Project statement updated 12/01/99 titled compilation of a History of Vegetative Treatments in the Park. States that park staff have taken photos and there is a need to organize them. Statement also says that the Rangeland Department at Eastern Oregon State College (University) has compiled reports annually with photos.

Excerpts from Draft Resources Management Plan (unsigned) but lists fall 1999 as the date for the Draft Plan. In folder labeled RMP Folder #2. Page 14. Restoration of Doan Creek

In 1995, the staff at Whitman Mission NHS contracted with Inter-Fluve, Inc. located in Hood River, Oregon to prepare a restoration plan for Doan Creek. Doan Creek's channel had been modified repeated times over the past 100 years so that the natural historic stream alignment was unclear. The intent of the study was to restore in part the natural stream system function of the north channel, and to allow irrigation to continue through the NHS. The primary goal of restoring Doan Creek was to reduce annual channel maintenance. The suggested restoration techniques, which are ready to be funded and implemented, would restore partial functionality by preserving or modifying vegetation and physically modifying some of the channel segments. In general, the northern channel would be restored to a natural meandering stream (closer to its original condition) with wetlands. Native hardwood trees and shrubs would be planted to provide shade and long term stability, and to increase the potential for wildlife. Since the southern channels have significant cultural resources, this area would be maintained as and irrigation-type channel. The banks of the irrigation ditch would be stabilized through the Mission grounds and the remainder of the irrigation channel would be assessed for other management options.

Page 17. Vegetation

The staff at Whitman Mission has compiled a vascular plant checklist and a collection of voucher specimens. There are 190 specimens in the herbarium. At this time there are no known federally listed threatened or endangered plant species within the NHS.

Whitman Mission is located on the southern extreme of the Palouse Prairie Region. Originally, perennial grasses, principally bluebunch wheatgrass (*Elymus lanceolatus wawawai*) which flourished in swards over the rolling plains dominated this prairie. Intermixed with it were smaller patches of sandberg bluegrass (*Poa secunda*) and Idaho fescue (*Festuca idahoensis*). The region is classified as the Agrpyron-Poa habitat type. Large native herbivores were generally absent from the Palouse, and because of this, the grasses evolved with a low

resistance to grazing. Subsequent grazing by domestic livestock and extensive cultivation for wheat are the main reasons why native perennial grasslands are now rare on the Palouse.

The Cayuse Indians were the dominant group inhabiting the area around Whitman Mission at the time of the Whitmans' arrival. The Cayuse practiced very little crop agriculture, depending instead on a partially nomadic existence that emphasized food gathering, horse raising, and salmon fisheries. Fire was used periodically by the Cayuse to burn particular areas to increase the production of wild forage and accessibility of plant foods, to facilitate hunting and travel by burning away underbrush, and to encircle game. The regularity with which the areas on or near the historic site were burned historically cannot be determined, but frequent cultural burning of any particular was probably rare.

It is probable that at the time the mission was established, a mixture of three plant communities occupied the site. At the time the mission was established in 1836, the Walla Walla River flowed through the site during times of high water. On the floodplains along the Walla Wall River and nearby Mill Creek, a narrow plant community consisting of dense tangled thickets of willows (*Salix spp*.), cottonwoods (*Populous trichocarpa*), wild dogwoods (*Cornus spp*.), blackberries (*Rubus spp*.), elderberries (*Sambucus spp*.) and other species common to riparian areas probably occurred. An association of perennial grasses, shrubs, and native forbs occupied the hillside area where soil depths and drainage were greater. Perennial grasses common to the Palouse dominated the rest of Whitman Mission.

Intermixed throughout the site was giant wild ryegrass (*Leymus cinereus*), a species preferring a year-round supply of soil moisture and occurring primarily on clay bottomlands and seepage areas. It now occurs as scattered large buches of grass, but historically, it may have been more extensive. It was this species that gave the Indian name to the location, *Waiilatpu*, meaning, place of the people of the rye grass.

It is likely that the Cayuse used the resources at the site at least periodically for centuries before the mission was established. Archeological evidence of modification to the natural conditions has not been documented. However, soon after the mission was established, an irrigation system was developed, crops were planted, and areas were opened to grazing by draft stock and cattle. A considerable number of stock animals moved through the mission was active—the introduction of domestic livestock, exotic plants and agriculture, and the removal of riparian vegetation for fire and building wood, were a portent of things to come for the entire Palouse Prairie.

Page 18: Exotic Plants

By 1985, major emphasis for maintenance within the NHS was being placed on revegetation and control of exotic plant species. Vegetation management has converted 60 percent of the NHS from exotic grasses and weeds to grasses that grew in the area during Whitman's era, or to grasses that have the same appearance as the native grasses. The NHS staff will gradually replace these native appearing grasses with native species.

In 1994, a vegetation plan was developed and implemented for the area surrounding the visitor center. In 1995, vegetative alternatives were developed for treating exotics on the banks of the irrigation channel. Some implementation has been initiated.

In 1997, an inventory of exotic pest plant species identified the following six species of concern; field bindweed (*Convolvulus arvensis*), jointed goatgrass (*Aegilops cylindrical*), poison hemlock (*Conium maculatum*), yellow starthistle (*Centaurea solstitalis*), Canada thistle (*Cirsium arvense*), and Scotch thistle (*Onopordum acanthium*). Control strategies for these species have been developed, and incorporate more extensive use of integrated pest management techniques.

Project statement dated 01/07/00 is for Control of Exotic Plant Populations. It is WHMI-N-307.000, Priority 1

It references the following studies: Cathy Gilbert's 1984 Landscape Study and Management Alternatives for Revegetation; Jim Romo's 1985 Weed Control and Revegetation Alternatives for Whitman Mission National Historical Park, and the 1993 Inter-Fluve Doan Creek Restoration Plan. The recommended activities include burning and spraying of weeds and non-native plants as well as bio-control agents. Species targeted include yellow starthistle, poison hemlock, and Canada thistle. Seasonal technicians will have primary assignment for the project, with assistance of YCC personnel.

Whitman Mission National Historic Site. General Management Plan, September 2000.

Excerpts:

Vegetation (Page 49) The staff at Whitman Mission National Historic Site has compiled a vascular plant checklist and a collection of voucher specimens. There are 183 specimens in the herbarium. At this time, there are no known federally listed threatened or endangered plant species within the NHS. (See figure 6, Vegetation)

Whitman Mission is located on the southern extreme of the Palouse Prairie Region. Originally, this prairie was dominated by perennial grasses, principally bluebunch wheatgrass (*Elymus lanceolatus wawawai*) which flourished over the plains. Intermixed with it were smaller patches of sandberg bluegrass (*Poa secunda*) and Idaho fescue (*Festuca idahoensis*). This region is classified as the Agropyron-Poa habitat type (formerly named *Agropyron spicatum*, new listing is *Pseudoreognaria spicata*). Large native herbivores were generally absent from the Palouse, and because of this, the grasses evolved with a low resistance to grazing. Subsequent grazing by domestic livestock and extensive cultivation for wheat are the main reasons why native perennial grasslands are now rare on the Palouse.

The Cayuse Indians inhabited the area around Whitman Mission NHS prior to the 1850s. They practiced very little crop agriculture, depending instead on a partially nomadic existence which emphasized food gathering, horse raising, and salmon fisheries. Fire was used periodically by the Cayuse to burn particular areas to increase the production of wild forage and accessibility of plant foods, to facilitate hunting and travel by burning away underbrush, and to encircle game. The regularity with which the areas on, or near, the historic site were burned

historically cannot be determined, but frequent cultural burning of any particular area was probably rare.

It is probable that at the time the mission was established, a mixture of three plant communities occupied the site. At the time the mission was established in 1836, the Walla Walla River flowed through the site during times of high water. On the floodplains along the Walla Walla River and nearby Mill Creek, a narrow plant community consisting of dense tangled thickets of willows (*Salix spp*.), cottonwoods (*Populus trichocarpa*), wild dogwoods (*Cornus spp*.), blackberries (*Rubus spp*.), elderberries (*Sambucus spp*.), and other species common to riparian areas probably occurred. An association of perennial grasses, shrubs, and native forbs occupied the hillside area where soil depths and drainage were greater. Perennial grasses common to the Palouse dominated the rest of the Whitman Mission.

Intermixed throughout the site was giant wild ryegrass (*Leymus cinereus*, formerly *Elymus cinereus*), a species preferring a year-round supply of soil moisture and occurring primarily on clay bottomlands and seepage areas. It now occurs as scattered large bunches of grass, but historically, it may have been more extensive. It was this species that gave the Indian name to the location, *Waiilatpu*, meaning, place of the people of the rye grass.

It is likely that the Cayuse used the resources at the site at least periodically for centuries before the mission was established. Archeological evidence of modification to the natural conditions has not been documented. However, soon after the mission was established, an irrigation system was developed, crops were planted, and areas were opened to grazing by draft stock and cattle. A considerable number of stock animals moved through the mission from the Oregon Trail, and there was ample opportunity for the introduction of exotic plants. The changes that occurred to the plants and the landscape during the time the mission was active-the introduction of domestic livestock, exotic plants and agriculture, and the removal of riparian vegetation for fuel and lumber-were a portent of things to come for the entire Palouse Prairie.

Revegetation Program (page 50)

In 1985, the NHS staff began a revegetation project with the objective to control non-native weeds that had invaded the park. Some of these plants were on the state and county noxious weed lists as targeted weeds for control and are still serious threats to local agriculture. The short-term goal of the NHS staff was to establish healthy stands of grass to successfully compete with these weeds. The non-native grass species were chosen for the following reasons: the species had a good chance for success against the noxious weeds and the weed seeds still in the soil, and they would be similar in appearance to grasses that may have been growing there 150 years ago. Once these grasses were established, the park staff then would be able to gradually replace the non-native grasses with native species thought to be present during the Whitman's time. This action is in concurrence with the 1984 *Landscape Study and Management Alternatives for Revegetation: Whitman Mission National Historic Site* which states that the overall goal for revegetation is to maintain the visual aspect of the historic period (USDI, 1984).

In 1989, the NHS staff established a native rye grass demonstration plot by the visitor center. It was planted in a native plant mixture of Magnar great basin wildrye (*Leymus cinereus*) and Sherman big bluegrass (*Poa secunda*). The Magnar great basin wildrye grows six to eight

feet tall and the Sherman big bluegrass grows two to three feet tall. The bluegrass did not compete well and the entire area is gradually becoming Magnar great basin wildrye.

In 1987 and 1988, the 28 acre river oxbow and pasture area was planted with both native and non-native species to reproduce the historic scene. The native Magnar great basin wildrye was planted along with two species of non-native grasses, reed canary grass (*Phalaris arundinacea*) and Alkar tall wheatgrass. The Alkar tall wheatgrass (*Elytrigia pontica*) is the main grass in this area and grows to four feet tall. The reed canary grass grows well on poorly drained soils.

Another native plant that has been discussed for possible use on the Mission grounds is Sodar streambank wheatgrass (*Elymus lanceolatus*). This plant is a native, sod forming grass that grows six to eighteen inches tall. It grows well on a variety of soils and can handle the dry conditions of summer.

Exotic Plants (page 51)

By 1985, major emphasis for maintenance within the NHS was being placed on revegetation and the control of exotic plant species. Vegetation management has converted 65 percent of the NHS from exotic grasses and weeds to grasses that grew in the area during the Whitman's era, or to grasses that have the same appearance as the native grasses. These native-appearing grasses will gradually be replaced with native species by NHS staff.

A vegetation plan was developed by the NHS staff and implemented for the area surrounding the visitor center. In 1995, vegetative alternatives were developed from treating exotics on the banks of the irrigation channel. Some implementation has been initiated.

In 1997, an inventory of exotic pest plant species identified the following six species of concern: field bindweed (*Convolvulus arvensis*), jointed goatgrass (*Aegilops cylindrical*), poison hemlock (*Conium maculatum*), yellow starthistle (*Centaurea solstitalis*), Canada thistle (*Cirsium arvense*), and Scotch thistle (*Onopordum acanthium*). Control strategies for these species have been developed, and incorporate more extensive use of integrated pest plant management techniques.

Have Map from Plan

A Draft Resource Management Plan in the "RMP" folder with associated year 2000 material has a section under the Exotic Species heading. The following is from that section:

By 1985, major emphasis for maintenance within the NHS was being placed on revegetation and the control of exotic plant species. Vegetation management has converted 60% of the NHS from exotic grasses and weeds to grasses that grew in the area during Whitman's era, or to grasses that have the same appearance as the native grasses. The NHS staff will gradually replace these native-appearing grasses with native species.

In 1994, a vegetation plan was developed and implemented for the area surrounding the visitor center. In 1995, vegetative alternatives were developed for treating exotics on the banks of the irrigation channel. Some implementation has been initiated.

In 1997, an inventory of exotic pest plant species identified the following six species of concern; field bindweed (*Convolvulus arvensis*), jointed goatgrass (*Aegilops cylindrical*), poison hemlock (*Conium maculatum*), yellow starthistle (*Centaurea solstitalis*), Canada thistle (*Cirsium arvense*), and Scotch thistle *Onopordum acanthium*). Control strategies for these species have been developed, and incorporate more extensive use of integrated pest management techniques.

Project Detail Sheet Excerpts: (FY2002)

Project Title: Control Exotic Plant Populations.

Description:

Problem Definition and Resolution: Controlling the invasion of non-native plants in order to maintain the health and vigor of grasses and forbs is the most effective way to maintain a sense of the historic scene. The park will continue to use prescribed fire. This cyclic funding will provide herbicides and bio-control agents. Park I & RM and maintenance staffs have over 10 years experience reclaiming weedy areas and maintaining native grasses. Park staff has used expertise from Eastern Oregon State College, University of Idaho, and Washington State University in addition to the USDA Natural Resources Conservation Service, and USDA Forest Service to provide advice.

Cost Effectiveness: Yellow starthistle can double its population in an area every year unless controlled with integrated pest management techniques. Spot spraying with herbicides and use of biocontrol methods is much more reliable and is a fraction of the cost of a two-year project to reclaim an area lost to noxious weeds. One Youth Conservation Corp enrollee will spend his/her time on weed control in the park.

Justification:

Resource management at Whitman Mission NHS focuses on the combination of cultural and natural resource preservation in an effort to communicate the historic scene during the active years of Whitman Mission (1936-1847). Cathy Gilbert's Landscape Study and Management Alternatives for Revegetation (1984) while not a complete cultural landscape report, contains management options for enhancing the cultural landscape while maintaining the historic integrity of Whitman Mission. Jim Romo's 1985 Weed Control and Revegetation Alternatives for Whitman Mission National Historic Site provided specific prescriptions for specific areas of the park. Using his plan has allowed the park to revegetate 70 percent of the park into native grasses or grass species very similar to those growing during the historic period. The 1993 plan by Inter-Fluve, Doan Creek Restoration Plan, covered revegetation and bank stabilization along Doan Creek and Whitmans' irrigation ditch that winds through the park. Continuing the revegetation and weed control program developed from these three plans is the most cost effective management alternative to mitigate noxious weed infestations and to maintain vigorous perennial

vegetation. These three plans cover the cultural landscape, the natural rangeland grasses, and the riparian zone that goes through the park. This project will allow us to continue an integrated program of exotic plant control.

Significance of the Resources at Risk:

Preserving a sense of the historic scene is the primary goal of most of the resources management program at Whitman Mission. Most of the park's 98 acres have been grazed or farmed since the Whitman era, so very few native plants were left. Revegetation is fundamental to creating areas for memorialization while providing visitors with a sense of the historic scene. Many of these exotic plants are on the county and state noxious weed lists and must be controlled.

Severity of Resource Threat, Problem or Need:

Yellow starthistle, poison hemlock, and a variety of other exotic plants gradually spread into the park's revegetated areas from uncultivated areas adjacent to the park-railroad right of way, state wildlife habitat, and uncultivated agricultural land. The park uses prescribed burning to enhance native grasses, but cyclic spot spraying and reseeding is necessary to control the spread of these non-native plants. Some of these exotics are on county, state, and federally targeted weed lists. Yellow starthistle spreads very rapidly and requires herbicide spot spraying until enough biocontrol insects live in and around the park. Areas of the park were once 90 percent covered with yellow starthistle, and after three years of intensive revegetation work, grasses now grow there. The park cannot afford to lose these areas to yellow starthistle again.

Funding amount requested: $6000. Planned FY 2001, Submission FY 2004.

Project Identification: PMIS-1106

Excerpts: Project Detail Sheets:

Title: Revegetate 5 acres of exotic plants-PMIS 68459

Excerpts. Description: This project will allow Whitman Mission to restore 5 acres of exotic vegetation to native grasses. This will include weed removal, preparing seedbed, sowing seed, and distributing bio-control agents for yellow starthistle and poison hemlock.

Project methodology: Park staff will treat 5 acres of exotic plants using a variety of integrated weed management methods including bio-control agents, herbicides, and tillage.

Component Funding Request: $7,000 which includes wages, biocontrol agents, and herbicides. Planned FY 2001, Submission FY 2001.

Component completion date: 9/21/01

Accomplishment report: The park hired a seasonal laborer who applied herbicides on selected areas of the park under the supervision of a Washington State certified pesticide

applicator. Approximately 7 acres were treated. Another acre was treated with a weed-eater to control exotic plants and allow native shrubs planted in 1999 to grow with less competition.

Excerpts Project Detail Sheet:

Revegetate 10 acres to maintain Historic Scene PMIS 82145

Description: This project will allow Whitman Mission to restore 10 acres of exotic vegetation to native grasses. Activities over the summer include removing weeds, preparing seedbed, sowing seed, and distributing bio-control agents for yellow starthistle and poison hemlock.

Measurable results: The 10 acres will have very few exotic plants once the native grasses become established the next growing season.

Component funding request: $8000, which includes wages, biocontrol agents and herbicide supplies. Planned FY 2004, Submission 2004.

Excerpts Project Detail Sheet:

Update Vegetation Map/Conduct Vegetation Inventory PMIS 58010

Description: The University of Idaho is working with parks in the Northern Semi-Arid Group to inventory vascular plants as part of the Biological Inventory initiative. The results of the project will provide the park with a high resolution non-native plant distribution map. A report will also be provided to the park describing the study, containing background information on each weed species class, and a prioritized ranking of each species in terms of their current level of impact and feasibility of control.

Measurable results: Whitman Mission will receive: [1] vegetation map in hard copy and GIS files; [2] written report of vegetation distribution and control measures for exotic species; [3] complete inventory of plants; [4] voucher specimens for plants not already catalogued.

Component funding request: $8000. Planned FY 2001, Submission FY 2001.

Excerpts-Project Detail Sheet:

Compile Report on Revegetation Program PMIS 68522

Description: This project will fund a researcher to compile a report on the revegetation effort at Whitman Mission over the last 15 years. After this project is completed, the park staff will have documentary evidence of what strategies have worked and what mistakes to avoid in the future. Restoring native grass species and controlling exotic vegetation has been ongoing for 15 years. The park does not have good statistics to show the success of the program. Photographs, proposed timetables, budgets, financial records, and annual accomplishment reports are scattered through different offices and files at the park and support office. Without an organized history of the revegetation project, the park staff has to rely on "institutional memory" and anecdotal evidence.

Measurable Results: This report could be shared among the Northern Semi-Arid Network and other parks engaged in revegetation. Spin-off articles in Park Science, George Wright Forum, or restoration and ecology periodicals or other publications would be encouraged. The park would adjust its revegetation program to incorporate the reports recommendations. The park staff will benefit from the better organization of files, and images related to revegetation and some of the data will be useful for GIS, the interpretive program, and GPRA reports (la01A) and goal setting. Restoring native vegetation is encouraged in the NPS Management Policies. This report will evaluate how well it has been done and provide recommendations on success and failures.

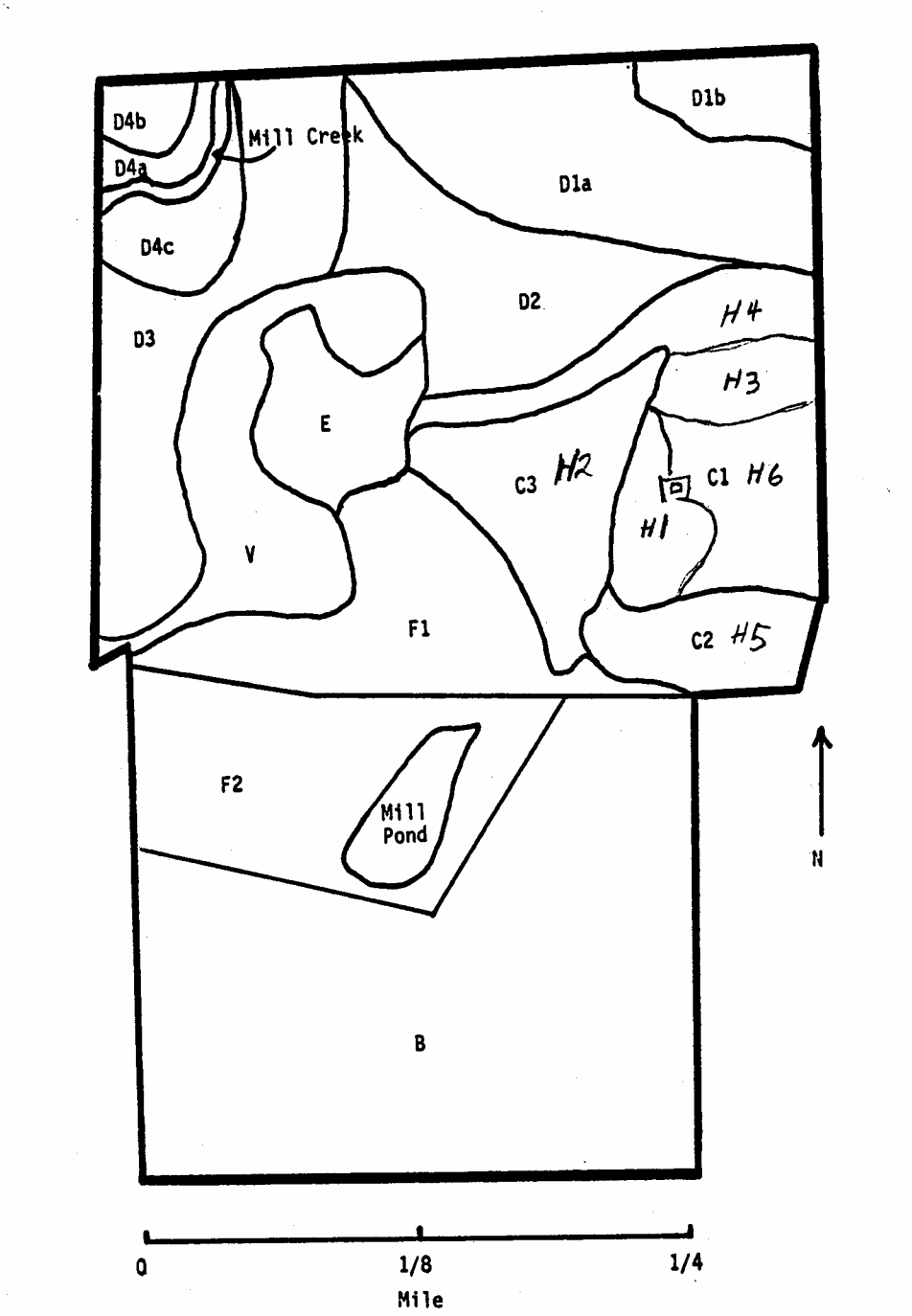
Component Funding Request: $11,000. Submitted FY 2001, Planned FY2002.

Letter: Dated March 11, 1981 from Jack Winchell, Park Interpreter, Whitman Mission National Historical Site, to Supervisory Park Ranger, Whitman Mission National Historical Site. Subject: Vegetation during Whitman's time.

Excerpts: During Whitman's time most of Walla Walla County was grassland. The grassland vegetation was *Agropyron spicatum* (bluebunch wheatgrass), *Festuca Idahoensis* (Idaho fescue), and *Poa secunda* (Sandberg bluegrass.) Shrubs were inconspicuous except for a scattering of *Chrysothamnus nauseosus* (gray rabbitbrush). Along rivers and on the higher elevations *Artemisia tridentata* (big sagebrush) was found. Numerous other grasses, shrubs and plants were found, but not in any great abundance, except in localized areas.

Whitman's farm and mission was located on a poorly drained valley fill that has slightly to strongly alkaline, silt loam soils. The primary vegetation was *Elymus cinereus* (giant wildlrye), and *Distichlis stricta* (alkali saltgrass). This was a two layered vegetative association with alkali salt grass being the short continuous phase and giant wildrye being superimposed in well spaced bunches.

In all, Whitmans' land included about 300 acres which lay in a triangle between the Walla Wall River, and its tributary, Mill Creek. Their confluence marked the apex of the triangle with the base of the triangle being about where Whitman's Mission's eastern most boundary is now located (the boundary on top of the hill). The triangle of land has twelve soils types, which were described in detail in the remainder of the letter.



Vegetation Restoration Management Units at Whitman Mission National Historic Site